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PESTICIDE SURVEY OF THE DUNK RIVER AND SOUTHWEST BROOK BASINS PRINCE EDWARD ISLAND, 1985

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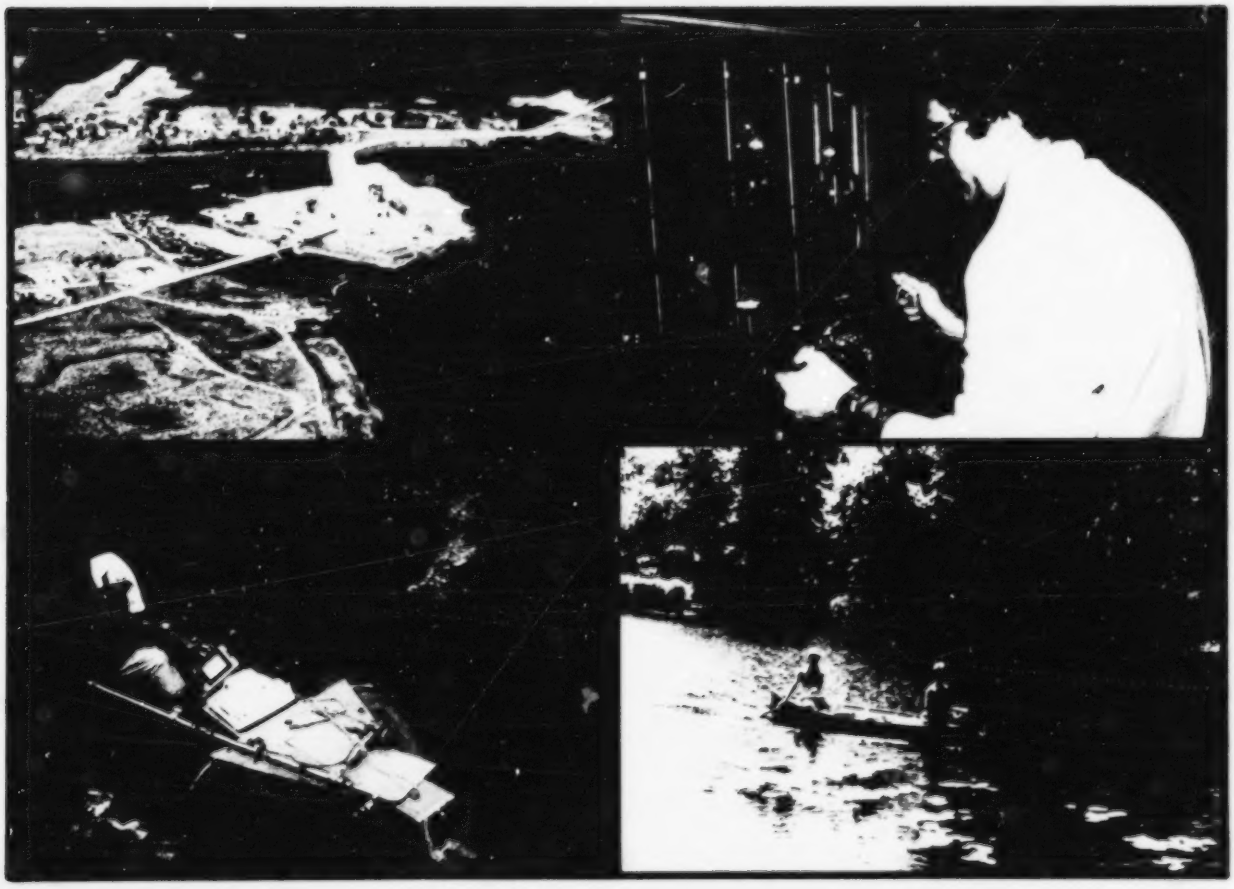

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INLAND WATERS DIRECTORATE
ATLANTIC REGION
WATER QUALITY BRANCH
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PESTICIDE SURVEY OF THE DUNK RIVER AND SOUTH WEST BROOK BASINS: PRINCE EDWARD ISLAND, 1985

IW/L-AR-WQB-87-117

INLAND WATERS AND LANDS

ENVIRONMENT CANADA

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ABSTRACT

An investigation of the levels of selected in-use pesticides and persistent environmental contaminants was conducted in water, bottom sediment and fish from the Dunk River and South West Brook basins of Prince County, Prince Edward Island. At some sampling stations, the triazine herbicide, atrazine, was observed in water along with the persistent organochlorine DDT, its degradation products and traces of mirex. Bottom sediments contained the same DDT metabolites in addition to low levels of alpha-endosulphan, while fish tissue contained only DDT and its metabolites.

RÉSUMÉ

Une enquête sur les niveaux de concentration de certains pesticides et autres contaminants persistants, présentement en usage, a été effectuée dans l'eau, dans le sédiment de fond et dans le poisson. Ces échantillons ont été recueillis dans les bassins de la rivière Dunk et du ruisseau South-West du comté de Prince, Île-du-Prince-Edouard. À certaines stations d'échantillonnage, l'herbicide triazine du nom d'atrazine a été observé dans l'eau, de même que le persistant pesticide organochloré DDT et ses produits de dégradation. Des traces de mirex ont aussi été détectées. Le sédiment de fond contenait les mêmes métabolites du DDT en plus de faibles concentrations d'alpha-endosulphan. Le tissu de poisson contenait du DDT et ses métabolites seulement.

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INTRODUCTION

Few studies in Canada have surveyed aquatic habitats for concentration of pesticides commonly used in agricultural areas. Gummer (1979) reviewed pesticide levels in surface waters of the prairie provinces of Canada and reported detectable levels of the phenoxy acid herbicides 2,4-D and 2,4,5-T and a number of organochlorine (OC) insecticides, mostly alpha-BHC, a Lindane isomer. He hypothesized that the OC's were distributed by atmospheric deposition, while agricultural and other uses were responsible for the herbicides. Clair and Bailey (1986) studied water, sediments and biota of the Annapolis Valley of Nova Scotia and analyzed for a wide range of pesticides. They found 2,4-D and alpha-BHC in water, as well as DDT and its by-products in sediments. Moreover, they proposed that the fungicides Diclone and Mancozeb, used on fruit trees, were being transported atmospherically since they were observed in sediment at sites several kilometers from where they had been applied.

As part of an ongoing program to look at environmental residues of in-use pesticides, the Water Quality Branch - Atlantic Region, with the cooperation of the Prince Edward Island Department of Community and Cultural Affairs, set out to measure the ambient concentrations in water, bottom sediment and selected biota of the major pesticides in use in the potato growing industry of that province. Two basins, the Upper Dunk River at Scale's Pond and Southwest Brook at Middleton Pond were selected as suitable

sampling sites. These were sampled before pesticides were applied, monthly during the summer and then in late October, after harvesting was complete.

The pesticides in use in the basins were identified by the Prince Edward Island Departments of Agriculture and Community and Cultural Affairs. The pesticides which they identified were then compared with those for which we had analytical methods and a compromise list was assembled. The objective was thus that this study would provide information on the concentration levels of pesticides that intensive potato farming under P.E.I. conditions would generate. Results from this study, in concert with analysis of published toxicological literature and preliminary bacterial toxicity tests carried out on the sediments by the National Water Research Institute, could then give some indication of the ecological health of the two ponds, and generate more questions leading to studies dealing with more specific problems unearthed by this general survey.

METHODOLOGY

Sampling Location

The two basins, Dunk River at Scale's Pond and Southwest Brook at Middleton Pond were 95 km^2 and 19 km^2 in area respectively. No settlements were upstream of sampling sites on Southwest Brook, but the Dunk River sites could be affected by the upstream communities of Emerald and Breadalbane which were approximately 5 km and 10 km distant from the inlet, Map 1.

Discharge was calculated by Water Resources Branch personnel from a standard stilling well gauge 2 km downstream from Scale's Pond, and at Middleton Pond from a manually read staff gauge. Sampling date discharge values over the period of study are shown in Table 1.

The main pesticides, herbicides and fungicides used in Prince Edward Island are listed in Table 2. Those for which analytical methods were available at the Water Quality Branch Laboratory are marked with an asterisk. Moreover, a number of long-lived pesticides that are no longer in use, were also analyzed, and are listed in Table 3.

Though 1985 sales figures of pesticides were not available, discussions with environmental and health officials suggested that the major insecticides were analyzed, and that the herbicides for

which we could analyze were also heavily used. Historical data from 1982 indicated that phencxy and quaternary ammonium herbicides, and organophosphate and carbamate insecticides were the most heavily used classes of compounds in Prince Edward Island. (Environment Canada, 1984)

Sample Collection

Sampling was done five times during the study period: mid-May and late in June, July, August and October of 1985. Except for the Middleton Pond visit in mid-June, three sediment sites were sampled in each pond on each sampling date, and their locations are listed in Table 4. Water samples were collected at Southwest Brook, one set each at the inflow and outflow of Middleton Pond, and one water sample was taken near the outflow of Scale's Pond. During the mid-May sampling, in the Middleton Pond only, three sets of samples were taken at the upper, mid and lower parts of the pond, one near each shore and one in the middle, the object of this effort being to determine if small scale spatial variations in sediment chemistry occurred in the pond.

Water samples for pesticides and major ion analyses were collected according to Water Quality Branch recommended methods, (Environment Canada, 1983). Preservation methods for samples are detailed in Table 5. Samples for major metal and nutrient analyses were collected at all the water sites in order to better describe the chemical conditions existing in the basins. The parameters

measured, their NAQUADAT numbers, (Environment Canada, 1985), and selected detection limits are listed in Table 6.

Sediment grab samples were collected using a 23 cm X 23 cm stainless steel Ekman dredge. At each site, at least three samples were taken, with the top 1.5 cm layer being saved for analysis. The three to four samples collected were pooled, thoroughly hand mixed in a stainless steel bowl, and the homogenate divided into 4 pre-cleaned aluminum containers and frozen immediately. Sediments from three containers were analyzed for pesticides, (Tables 2 and 3), while the fourth was reserved for carbon and particle size analysis, as well as to serve as a backup in case of sample depletion. The choice of this sampling scheme was to reduce variability and thus give greater confidence in the data interpretations.

The third part of the investigation involved the collection of forage fish to observe if any environmental contaminants were finding their way into the food chain. To this end, galvanized metal minnow traps were used to collect minnows from Middleton Pond in May, July and August and from Scales Pond in May, July, August and October. The traps were located at a depth of 0.5 meters and close to the shoreline usually in the vicinity of some perennial growth. The traps were left in place from 24 to 72 hours depending on the catch. As the traps were tended, a representative sample was taken, placed in pre-cleaned aluminum containers, and frozen until analysis.

A list of the environmental contaminants analyzed, their NAQUADAT parameter codes, and detection limits for fish is given in Table 7.

Twice during the study period, June and September, additional sediment samples were collected for bacteriological toxicity testing at the National Water Research Institute.

Analytical Methodology

All analyses were performed using the methods and procedures described in the Water Quality Branch Method Manual, (Environment Canada, 1979), as well as methods obtained from other external sources. The NAQUADAT Dictionary of Parameter Codes, (Environment Canada, 1985), contains brief descriptions of the analytical methodologies. Any parameter codes that are of the 89... or 99... series are awaiting NAQUADAT approval, or are in house methods that represent Branch analytical instrumentation capabilities.

Bailey (1985) has summarized the analytical procedures that were applied for carbamate, organophosphate pesticides, and triazine herbicides in bottom sediment, and for lipid content of fish.

It should also be noted that during the study period, the Water Quality Branch Analytical Services Division, Atlantic Region,

were installing a post column reaction system to the high performance liquid chromatograph in order to perform direct injections of an aqueous sample for carbamate insecticides, and thus avoid the degradation problems encountered with the liquid-liquid solvent extraction.

This change in methodology also effected a change in the detection limit of aldicarb whereby it shifted from 0.02 ug/L with the liquid-liquid extraction to 3.0 ug/L utilizing the direct injection method. The change of detection limit was necessary in order to maintain confidence in the analytical results obtained.

In the case of positive results, samples were re-analyzed on a column of different polarity. Organochlorine and polychlorinated biphenyls were analysed through simultaneous injection onto two gas chromatograph capillary columns of different polarity. Relative retention time and peak response were used to confirm the presence of the compounds of interest.

On two occasions, extra sediment samples were taken at a number of sites, frozen and sent to the National Water Research Institute, Burlington, Ontario, for genotoxicity tests. The methods used in this work are described in Dutka et al. (1983).

Quality Control

Quality control of samples involved two approaches:

triplication and spiking. Replication of sediment samples was described above. During each trip water samples were taken in triplicate at a site randomly chosen. Also on a random basis, water and sediment samples were spiked with known amounts of pesticides. The samples were then preserved and returned to the laboratory for analysis.

Results and Discussion

Water Chemistry

Tables 8(a), 8(b) and 8(c) display major ion, nutrient and physical parameters for the inflows and outflows of both Middleton Pond and Scale's Pond over the study period, though no samples were taken in May at Middleton Pond. Both sites show similar values for all parameters, which are typical for Prince Edward Island waters, (McNeely and Neimanis, 1978). pH levels are generally well above 7.0, indicating well buffered waters. Colour and DOC are low, suggesting low inputs of organic matter from soils and bogs at the sampling times. Turbidity was also generally low, though one case of a value of 6.8 at the Middleton Pond outflow is elevated. As these streams drained agricultural fields, occasional high values are not surprising.

The major ion data falls within the ranges of previously observed values from a NAQUADAT station (00PE01CB0001) which is 5.5 km east of Central Bedeque and downstream of the junction of the Southwest Brook and Dunk River. These historical data total 53 samples taken from September 1980 through to December 1984.

Table 9 contains results for the analysis of trace metals in water. The levels of copper, lead, zinc and cadmium were always at or below their respective detection limits. These are also below guidelines for protection of aquatic life, (McNeely *et al.*, 1979).

Positive values for iron, manganese and extractable aluminum were observed with the concentrations of iron falling within the guidelines for protection of the aquatic environment, (McNeely et al., 1979). A tentative limit for aluminum has been proposed at 0.100 mg/L by the International Joint Commission, (McNeely et al., 1977). On three occasions the Middleton Pond outflow site exceeded the guideline. The extractable aluminum values decreased over the sampling period indicating that the values could have been a function of the basin discharge.

No toxic limits for manganese exist, thus the observed values can be only related to drinking and irrigation guidelines which the samples meet.

Two properties of sediments were also analyzed to provide background information which could be useful in interpreting pesticide data: organic carbon content, and particle size. The results of the organic carbon content were lower at the May sampling, before both in-pond metabolism and runoff processes could load the sites with newly produced or deposited carbon. The June, July and August samplings generally all showed similar carbon levels at each site, with a pattern of higher carbon content at the further downstream sites being dominant, (Tables 10 and 11).

Particle size analysis was only done on samples from the May and July samplings, Tables 10 and 11, but as they both show somewhat similar patterns in distribution, it can be assumed that

the sediment quality was not very different in the June or August sampling. In both cases, results show the sediments dominated by the silt fraction, with sand and clay being somewhat similar in distribution. No great differences were observed between upstream and downstream sites, though in May there were greater differences in dominance between sites than in July.

Pesticide Results

Water

Results of the analyses are shown in Tables 12, 13 and 14. The tables also show the results of the replication component of the quality control part of the study. Unfortunately, no May water sample was collected at Scale's Pond, so that no comparison could be made between before and after the beginning of pesticide use.

A number of organochlorine pesticides no longer in use, and not considered very water soluble, are still being measured. p,p'-DDT, p,p'-DDD, p,p'-DDE and heptachlor were measured, albeit at levels near the detection limit. This is expected because of their high stability, persistence, high usage in the past, and presence in bottom sediments. Also measured, were gamma and alpha-BHC, though more frequently in Scale's than at Middleton Pond. One surprising organochlorine compound also measured in the samples was mirex, which is bioaccumulative, persistent and displays many dispersal properties similar to those of DDT and

PCB's (Polychlorinated Biphenyls), (Fisheries and Environment Canada, 1977). The levels of mirex ranged from 0.001 ug/L to 0.006 ug/L which is slightly above the detection limit of 0.001 ug/L. The likelihood of field contamination by the mixed spiking solution is low as no other anomalous values were observed. Laboratory contamination is unlikely also, as the reference standard for mirex is part of a general organochlorine standard and again no anomalous values were observed. No mirex was observed in any of the sediment or fish samples, from either Scales or Middleton Ponds.

As the replication aspect of the study shows consistency, with the exception of the June sampling at the lower Middleton Pond site, there is evidence that sample contamination is not the source of the values.

Mirex has been observed in the Atlantic ecosystem in migratory birds that wintered in the southern United States and in cod livers from the Atlantic Coast. It was postulated that the Gulf Stream transported the mirex from the southern United States. (Fisheries and Environment Canada, 1977)

Brun (1982, 1983, 1984) studied trace organic contaminants in rain events at Ellerslie, Prince Edward Island, NAQUADAT station number 33PE01CA001, and reported that mirex was less than the detection limit of 0.001 ug/L for each monthly sample for the three years studied. The studies at Ellerslie dealt only with wet precipitation and did not look at any corresponding dry fallout.

Of the pesticides known to be used in the fields draining into the sampling sites, atrazine was the only one which was measured in water samples with a range of positive values of 0.011 ug/L to 0.017 ug/L. Values were generally one half to one quarter of those measured in the Annapolis Valley in 1984, (Clair and Bailey, 1986). The pattern that did emerge though, was that no measurable values were reported in May, before atrazine use began, and that atrazine was found in Scales Pond and Middleton Pond inlet from June onward whereas in Middleton Pond outlet the first positive values did not appear until the July sampling date. It should be noted that the frequency of detectable levels was higher in the inflow to Middleton than at the outflow. This may suggest that some breakdown of the parent compound is occurring in the Pond itself, but more work would be needed to confirm this hypothesis.

Sediments

The various insecticides, herbicides, contaminants and selected breakdown products that were analyzed in sediments are listed in Tables 2 and 3 along with their respective detection limits.

There were no positive sediment values reported for the organophosphate, carbamate and phenoxy compounds analyzed. Most of the organochlorine compounds were below detection limits with the exception of p,p-DDT, o,p-DDT, p,p'-DDD, p,p-DDE, and

alpha-endosulphan (Tables 15 and 16). The alpha-endosulphan values were at or slightly above the detection limit of 0.001 mg/kg and did not exceed a single high value of 0.005 mg/kg.

The metabolites of DDT were present in all of the sediment samples taken with a value range of 0.003 to 0.170 mg/kg being observed. These findings are not surprising as a study by Bailey (1983) found a range of 0.007 to 0.130 mg/kg in an impoundment study of the Saint John River Basin, and Water Quality Branch surveys of 1979 and 1980 found a range of 0.001 to 0.110 mg/kg in fourteen of twenty-nine sites around the Atlantic Region.

The agricultural activity of the area and the past widespread usage of DDT has been the contributor to the observed data. The bioaccumulation and persistence of DDT and its metabolites has been well documented.

A comparison of total DDT substrates in mg/kg to the amount of organic carbon in mg/kg, Figure 1, did not produce a good linear relationship. There appeared to be some correlation in Scales Pond but there was also a much broader range of values for both variables. The Middleton Pond values for total DDT-substrates was much lower and the range of carbon content was considerably narrower thus making it difficult to discern any appreciable trend. The R-square value of 0.528 for Scales Pond and 0.075 for Middleton Pond show that there is a somewhat positive correlation for Scales Pond but that the relationship is not linear for the Middleton Pond

site. The bottom sediments also contained small twigs, grass and other materials which could introduce large variations in the organic carbon content.

Positive values for alpha-endosulphan were observed throughout the study period at all Scales Pond sites at or slightly above the detection limit of 0.001 mg/kg. Similar values were observed at Middleton Pond with the major exception being that no positive values were found for any of the October sediment samples.

Endosulphan is a broad spectrum contact insecticide that is used on vegetables, grains and tobacco. It may persist in sediments and can be metabolized by aquatic micro-organisms in well oxygenated water, (Environmental Protection Service, 1982). Brun (1983, 1984) reported finding alpha-endosulphan and beta-endosulphan in wet precipitation at Ellerslie, Prince Edward Island during July, August and September of 1983 and in August of 1984. His findings support the link to agricultural practices as to the time when positive values were observed.

The absence of any detectable levels of organophosphorus or carbamate compounds leads one to believe that either they were not used in the immediate area, did not reach the water course, or were at levels too low to detect.

Read (1986) found that in fields previously treated with carbofuran, a carbamate, there was a more rapid degradation curve

of this pesticide due to increased microbial breakdown. This also occurred in soils above pH 6.0. He put forward the hypothesis that bacteria can adapt to utilizing carbofuran as a food source. Research also indicates that carbofuran can be rapidly metabolized in plants to 3-hydroxy carbofuran, (Kuhr and Dorough, 1976).

In general, organophosphorous pesticides are less persistent than the organochlorines. They may undergo photochemical degradation, chemical oxidation and hydrolysis, and metabolic degradation by plant uptake, (Chau and Afghan, 1982). It is also known that some organophosphorus insecticides will degrade more quickly in non-sterile soils due to microbial action while others will break down due to chemical action, (Miles et al., 1979). Miles also proposed that microbial degradation was the principal degradation pathway for chlorofenvinphos in organic soils.

Carbamates and organophosphorous insecticides are generally not as stable as the organochlorine group thus breaking down faster either chemically or biologically, (Keachie and Cote, 1973). Aldicarb, for example, though it can be easily leached and translocated, displays rapid breakdown to its sulfoxide in silty clay loam, clay and organic soils with a half-life of 7 to 12 days, (Kuhr and Dorough, 1976). They also indicate that plants principally metabolize aldicarb via oxidation to aldicarb sulfoxide and aldicarb sulfone. This rapid breakdown makes finding the parent compound most difficult.

Though mirex was observed in water, none was detected in any of the sediment samples. This raises the possibility that perhaps the top 1.5 cm of sediment is composed of more recent sediment that has been deposited due to agricultural soil runoff and erosion. Any recent deposition could then cause the detection limit to be altered so that mirex is now below the detection limit. No samples were taken below the 1.5 cm top layer so this hypothesis cannot be verified.

Fish

All the minnows caught were three spine stickleback (Gasterosteus aculeatus) ranging in length from 30 mm to 50 mm. Widely distributed in the waters of Atlantic Canada, the three spine stickleback has an average size of 50 mm and a maximum of 75 mm fully grown. It feeds on worms, drowned aquatic insects, larvae and eggs and fry of fish, (Fisheries Research Board of Canada, 1973).

Fish samples that were collected during the study period were kept frozen until analysis, at which time they were homogenized and sub-sampled for analytical purposes. Parameters investigated were based on the availability of analytical methods and were kept solely to the organochlorine class of compounds. Positive values were obtained for the metabolites of DDT in all samples taken (Tables 17 and 18). The metabolites found were p,p'DDT, p,p'-DDT, o,p'-DDD, and p,p'-DDE, with p,p'-DDE displaying the highest levels, 0.09 mg/kg to 0.15 mg/kg of fish. Bailey (1985) reported total DDT metabolite values as high as 0.34 mg/kg in longnose (Catostomus commersoni) and white sucker (Catostomus catostomus) taken from the Aroostook River. Positive values for DDT and/or its metabolites in fish have been observed in lakes and rivers of the Annapolis Valley of Nova Scotia, (Clair and Bailey, 1986) and in Labrador, (Lockerbie and Clair, 1983).

There was one positive response of 0.001 mg/kg for

alpha-endosulphan in the October sample from Scales Pond which is at the detection limit of 0.001 mg/kg. Considering that alpha-endosulphan was observed in sediments from Scales Pond, it is not surprising that it was detected in fish albeit at a very low level. It should be noted though, that it was a positive response in one sample of seven and should not be weighted heavily due to the sample size and the low level.

Quality Control Results

Water

Results of the water spiking study are shown in Table 19. Spikes were replicated on three separate occasions. First, in May the spiking was done in triplicate in the field. Three further samples were collected and brought to the laboratory where they were again spiked with the original stock pesticide spiking solution. Single spikes on field samples were done in June and August, while triplicate field sample spikes were done in October. A spike with a very limited number of parameters was done in the July trip.

Results of this aspect of the study are not satisfactory for a number of parameters. We arbitrarily selected a standard deviation of +/- 25% of the mean as being acceptable reproducibility over the study period, and found that 17 of the 25 parameters spiked were outside this limit, with the highest variability being in p,p-DDE,

heptachlor, alpha-endosulfan, 2,4-D and carbaryl. Study of those data, as well as a close look at field procedures, suggested that some problems in field procedures could have caused inaccurate values in the July spikes. When we removed these values from calculations, only heptachlor variability changed drastically to +/- 10.2% from 182.7, while of the whole group 14 of the 25 were still outside the arbitrarily designated 25% limit. Obviously, a serious problem had occurred with heptachlor in August, but we have no means of finding out where the problem lay. Of the other parameters, especially the OC's, variability decreased somewhat with the removal of the August values (Table 19), suggesting that the problems with heptachlor were also involved in decreasing the quality of the other parameters.

Generally, mean recoveries over the study period were within the +/- 25% recoveries considered adequate by WQB, though, as noted above, there could be large variances between trips. Poor values were recorded for p,p'-DDT and p,p'-DDD, though conversion of o,p'-DDT and p,p'-DDD into p,p'-DDE in the spiking solution could be the cause of the problem. Poor recoveries of beta-endosulfan, mirex, endrin, 2,4-D and 2,4,5-T, as well as malathion, guthion and carbaryl, could all be due to either spike degradation or matrix interferences in the sample, though exact causes cannot be identified, due to the sample spike methodology.

When these values are compared with the previous year's work in the Annapolis Valley, we find similar poor recoveries for

malathion and carbaryl, but poorer results in P.E.I. for p,p'-DDE, beta-endosulfan, guthion and 2,4-D. Alpha-endosulfan and atrazine values were similar for both years.

Sediments

As was evident with the water quality control samples, many inconsistencies were also present in the sediment field spikes, (Table 20). All the parameters spiked show anomalous high and low values which create havoc with any statistical analysis. There was a large divergence among triplicate and duplicate spikes for several of the parameters; p,p'-DDT, o,p'-DDT, p,p'-DDD, p,p'-DDE, heptachlor epoxide, and alpha-endosulphan.

Several inconsistencies that are of major concern are the extremely high recoveries for heptachlor (average = 292%), the extremely low recoveries for beta-endosulphan (average = 11%) and endrin (average = 24%), the absence of malathion and phorate in the July and August spikes, and the low recoveries for all the carbamates.

As the spiking solution for water and sediment is the same, the high heptachlor recoveries are not due to spiking error but are more likely related to matrix and chemical affects. As sediment samples for organochlorine and polychlorinated biphenyls are acid cleaned with concentrated sulphuric acid, it may be possible that either endrin and beta-endosulphan are undergoing chemical changes that could be interfering with heptachlor thus giving a higher positive result, or that some form of microbial action is taking place. Dieldrin which was also included in the spiking solution is known to break down under strongly acidic conditions.

The absence of malathion and phorate, two organophosphorous insecticides in the July and August spikes was due to the inadvertent error of cleaning the extract with concentrated sulphuric acid. Normally the sample extract is split with one fraction being acid cleaned and the other not.

The non-existent recoveries for aldicarb, aldicarb sulfoxide, aldicarb sulfone, and the low recoveries for carbaryl and carbofuran were due to the spiking solution being at too low a level for the compounds to show up via direct injection on the post column reaction system.

Overall it would appear that the organochlorine results were not as troublesome as the organophosphate, carbamate and herbicide results.

The laboratory sediment spikes for atrazine, Table 21, were generally good, albeit with some variance within the triplicate samples. The mean recovery was 89% with a standard deviation, n-weight of 8.8.

Quality Control Recommendations

The discrepancies shown above reveal that we have an inadequate understanding of how spiking solutions behave in storage, in the field samples, and in the analytical clean-up

procedures. To remedy this shortcoming we suggest the following procedure to try to identify the weak links in the spiking process:

(1) Decrease the number of parameters in spiking solutions, while ensuring that each major pesticide group is represented.

(2) Decrease the importance of OC's in spiking solutions, as these are relatively stable, and increase the importance of the non-stable groups, such as the organophosphorous, carbamates, and herbicides.

(3) Spike laboratory distilled water before leaving the laboratory, to be assured of the integrity of the solution.

(4) Spike distilled water, as well as field samples in the field.

(5) Spike distilled water with the solution taken to the field, in the laboratory, at the end of the trip, to ensure the integrity of the solution and to obtain accurate recovery data.

(6) Investigate the usage of a standard reference manual for sediment analysis and for spiking.

With the above procedures, we should be in a position to identify the weak links in the spiking process, and would be better able to determine if the problems occurring in spiked samples are also possibly affecting actual field samples. It is imperative to eliminate as many variables as possible in order that a quality assurance/quality control program will ensure confidence in the analytical results.

Sediment Toxicity Testing

Past studies, Bailey (1985), Clair and Bailey (1986), and Lockerbie and Clair (1986), as well as this study, show that positive contaminant values have been observed in bottom sediments. It is not clear however what hazard these contaminated sediments pose to the aquatic environment. In order to investigate the impact of the bottom sediment, bacterial toxicity testing on samples from the June and September sample collection, was undertaken by the National Water Research Institute in Burlington, Ontario.

By definition, toxicity is the inherent property of a substance to cause an adverse biological effect, (Balls et al., 1983). Toxicity testing is performed in order to assess the toxic potential of a substance, assist in the prediction of a hazard and to aid in priorizing site selection for environmental screening studies.

A variety of microbiological, biochemical, and bioassay tests may be used to assess the toxicity of a sediment including, escherichia coli (E. Coli), cholesterol, coliphage, coprostanol, dehydrogenase activity, genotoxicity and microtox tests. (Dutka et al., 1986)

The salmonella microsome or Ames test is a bacterial genotoxic test that has been used to provide an indication of the ability of a substance to interact with DNA.

It has been reported by various authors, Balls et al. (1983), Dutka et al., (1986) and Samoiloff (1986), that sediments containing priority pollutants may not necessarily be toxic to aquatic biota while some sediments can be toxic and yet not contain any of the 129 USEPA priority chemical pollutants.

Within the two sets of samples examined, all the samples from Scales and Middleton Ponds were screened using the Microtox and Genotoxicity tests while the June samples were also screened with the Spirillum Volutans protocol, (Table 22). The first set of data from June indicates that there was an observed toxic effect to Spirillum Volutans after 140 minutes in the Scales Pond sediment above the upper tributary and a positive genotoxic effect was observed for the Middleton "B" sediment.

The September sampling shows that at Scales Pond 600 m above the dam 44.4% of an extract caused an LC50 effect, using the

microtox protocol, while all the sites displayed a genotoxic effect. The value in the genotoxicity column is the amount of wet weight sediment in grams, extracted with ultra pure water, that will result in a positive response. In all cases toxicity is related back to 1 gram of wet weight sediment.

It should be noted that these tests are somewhat specific as to what test organisms are used and that considerable variability has been observed within homogenized samples. A battery approach to toxicity testing would appear to be the most effective means of investigating sediment toxicity, (Dutka et al., 1986).

As sediment toxicity testing is a new and developing area in environmental studies, no guidelines or limits for toxicological data have been determined, spatial and temporal variations have yet to be fully understood, and within the battery testing approach relative weightings are still somewhat imprecise. This combination of variables makes data interpretation extremely difficult. As the technology evolves more confidence in toxicological data may result. The best combination of chemical trace analysis and toxicological testing has yet to be determined.

Based upon the toxicity testing that was performed one cannot make any definitive statements as to the ecological health of the systems but only present the observed data.

CONCLUSIONS

In summation, it was found that some of the waters of the Dunk River and Southwest Brook contained traces of DDT and some of its degradation products along with traces of mirex and atrazine. The timing of the presence of atrazine is consistent with agricultural applications. The sediments of the two basins contained only DDT and its degradation products along with trace levels of alpha-endosulphan while the fish contained DDT and its metabolites only. These observations are in agreement with work done in other parts of the region and reflect the past agricultural usage of DDT.

There appears to be merit in obtaining organic carbon content for sediment but direct relationships are difficult to ascertain when working with very low levels of environmental contaminants.

In spite of the known usage of certain insecticides in the organophosphorous and carbamate groups, none were detected in the three media analysed. This indicates that they were not applied in the area, were not reaching the water course for chemical, metabolic, or physical reasons, or were present at levels too low to detect.

Another aspect that must be considered vital, is obtaining accurate information as to what biocides are actually being applied and when they are applied. This information can be difficult to obtain as it necessitates contacting farmers, and suppliers who may

not be eager to disclose the amounts of active ingredients and their formulations. It is often difficult for analysts to develop analytical methodologies on short notice in response to in-use pesticide applications.

As the discharge from each basin decreased over the summer, it is difficult to ascertain the effects of surface runoff and erosion of agricultural land where biocides may have been applied. The analysis of post-application soil samples could have been useful in verifying the use of a particular compound and the examination of post rain event runoff and suspended solids may have given some indication as to the fate.

There were several problems evident with the quality assurance - quality control aspect of the study. Many of these trouble areas have been addressed by Arseneault and Howell (1985) and have been resolved for future programming.

The two tests employed to assess sediment toxicity did not provide enough data and did not include enough testing protocols from which to make sound statements as to sediment toxicity. The application and interpretation of toxicological testing to environmental monitoring in general and to water quality specifically is still unclear.

RECOMMENDATIONS

From the aforementioned conclusions and previous discussions, the authors would like to put forward the following recommendations to be considered when designing and implementing a toxic substance assessment study:

1) Determine as accurately and as early as possible, the actual in-use biocides that are being used, along with those that have been used in previous seasons, thus allowing the analysts more time to modify methods and determine recoveries.

2) In the case of agricultural applications, obtain pre-application and post-application soil samples in order to verify that a particular agent has been used.

3) Investigate post-rain event run-off into the basin of interest by examining both the water and suspended solids, to help determine the fate and pathway of a chemical.

4) Where practical and feasible, analyse for parent compounds and primary degradation products or metabolites especially for those chemicals that are rapidly degraded.

5) Maintain a high degree of quality control/quality assurance, approximately 20-25% of the program, by implementing the recommendations put forward in the quality control

discussions.

As a result of this investigation of the Dunk River and Southwest Brook, there are a few recommendations that could be incorporated into future work in these basins:

1) By means of a large volume extractor, investigate the observed trace levels of mirex in water and contaminants that might be present in the suspended solids.

2) Obtain and analyze sediment core samples to confirm or disprove that recent sediment deposition has diluted the top layer of sediment thus placing mirex below the detection limit.

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TABLE 1.

DISCHARGE FROM THE BASINS OF INTEREST
IN m3/S

	SOUTH WEST BROOK AT MIDDLETON POND	DUNK RIVER AT SCALES POND
	INSTANTANEOUS	MEAN DAILY
13-MAY-85	0.67	4.14
14-MAY-85	0.65	4.07
15-MAY-85	0.49	3.76
28-JUN-85	0.31	2.15
24-JUL-85	0.23	1.41
28-AUG-85	0.19	1.14
30-AUG-85	0.02	0.83

TABLE 2.

MAJOR PESTICIDES AND HERBICIDES IN USE ON PRINCE EDWARD ISLAND; BASED ON SURVEYS BY PEI DEPARTMENT OF COMMUNITY & CULTURAL AFFAIRS, AND ENVIRONMENTAL PROTECTION SERVICE. (GILL 1984).

NAME	CLASSIFICATION	NAQUADAT PARAMETER CODES AND DETECTION LIMITS. WATER-UG/L	SEDIMENT-MG/KG
DISYSTON *	INSECTICIDE	18215L-L0.04	----------
ALDICARB **	"	89297L-L0.02	89294L-L0.003
PHORATE *	"	18300L-L0.04	89048L-L0.005
CHLOROFENVINPHOS *	"	18225L-L0.04	89960L-L0.01
CARBOFURAN *	"	89271L-L0.01	89272L-L0.005
METHIDATHION *	"	89090L-L0.10	89092L-L0.10
DIAZINON *	"	18207L-L0.04	----------
METHAMIDOPHOS	"		
METASYSTOX	"		
FENVALERATE	"		
PIRIMICARB	"		
CROTOXYPHOS	"		
RONNEL	"		
PERMETHRIN	"		
DINOSEB	HERBICIDE		
PARAQUAT	"		
DIQUAT	"		
2,4-D *	"	18500L-L0.004	18501L-L0.004
MCPP	"		
DALAPON	"		
METRIBUZIN *	"	89820L-L0.04	----------
ATRAZINE *	"	89802L-L0.02	89803L-L0.001
MCPA	"		
CHLORPROPHAM	"		
NAPTALAM	"		
AMITROLE	"		
MALEIC HYDRAZIDE	"		
METALAXYL	FUNGICIDE		
THIABENDAZOLE	"		
DIFOLATAN	"		
MANEB	"		
MANCOZEB	"		
BENOMYL	"		
CHLOROTHALONYL	"		
METIRAM	"		

* PARAMETERS FOR WHICH ANALYTICAL METHODS WERE AVAILABLE
** DETECTION LIMIT FOR ALDICARB CHANGED FROM L0.02 UG/L TO L3.0 UG/L DUE TO CONVERSION TO A DIRECT AQUEOUS INJECTION AS OPPOSED TO SOLVENT EXTRACTION

TABLE 3.

PESTICIDES, AND BREAKDOWN PRODUCTS NOT CURRENTLY USED IN PRINCE EDWARD ISLAND BUT OF INTEREST AS ENVIRONMENTAL CONTAMINANTS

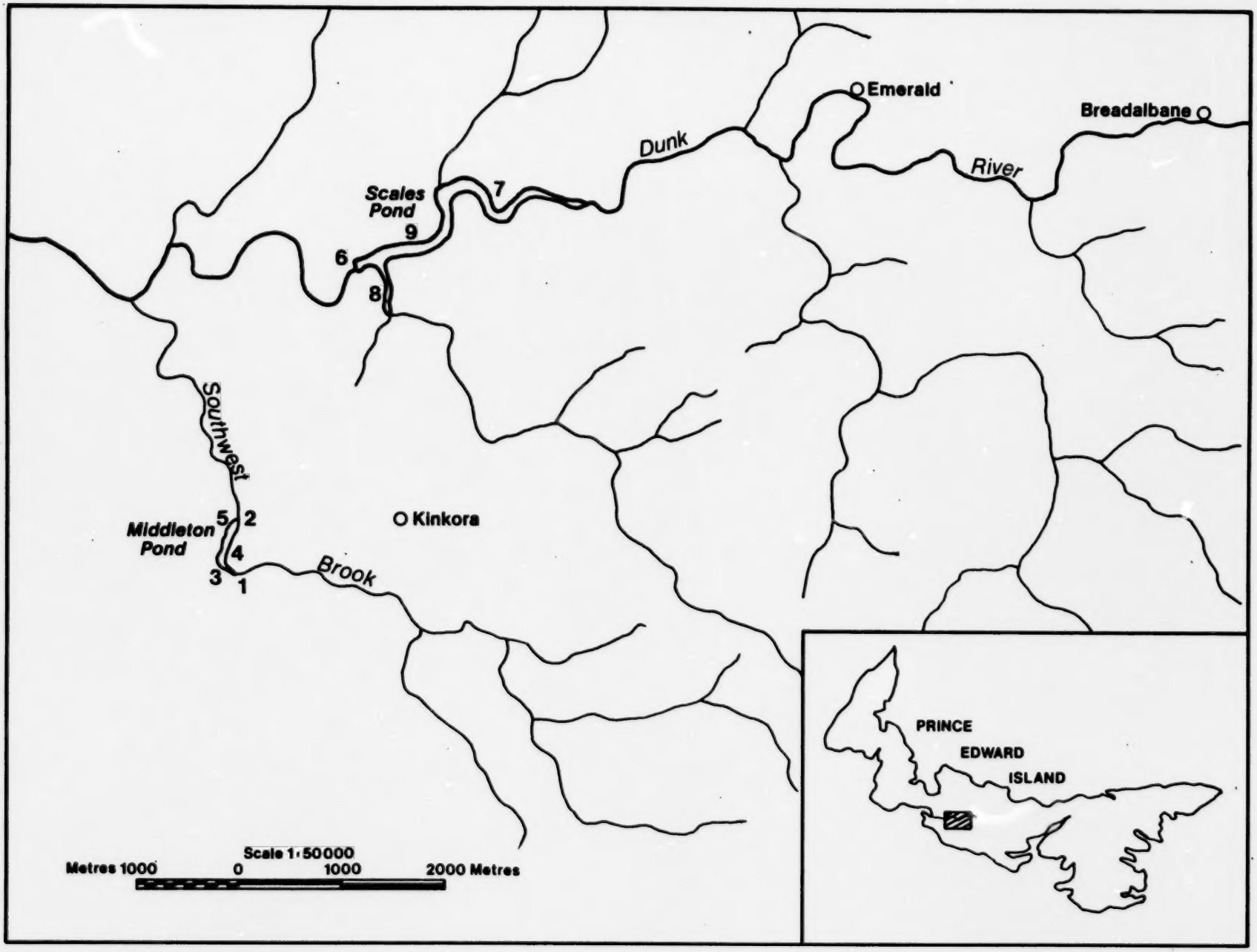
NAME	CLASSIFICATION	NAQUADAT PARAMETER CODES AND DETECTION LIMITS	
		WATER--UG/L	SEDIMENT--MG/KG
P,P-DDT	INSECTICIDE	18000L-L0.001	18009L-L0.001
O,P-DDT	"	18005L-L0.001	18008L-L0.001
P,P'-DDD	"	18010L-L0.001	18012L-L0.001
P,P-DDE	"	18020L-L0.001	18026L-L0.001
P,P-METHOXYCHLOR	"	18030L-L0.01	18034L-L0.05
HEPTACHLOR	"	18040L-L0.001	18043L-L0.001
HEPTACHLOR EPIXIDE	"	18045L-L0.001	18048L-L0.001
ALPHA-ENDOSULFAN	"	18050L-L0.01	18054L-L0.001
BETA-ENDOSULFAN	"	18055L-L0.01	18058L-L0.01
ALPHA-CHLORDANE	"	18060L-L0.005	18063L-L0.005
GAMMA-CHLORDANE	"	18065L-L0.005	18068L-L0.005
GAMMA-BHC	"	18070L-L0.001	18079L-L0.001
ALPHA-BHC	"	18075L-L0.001	18074L-L0.001
MIREX	"	18125L-L0.001	18128L-L0.001
ALDRIN	"	18130L-L0.001	18133L-L0.001
ENDRIN	"	18140L-L0.01	18143L-L0.01
DIELDRIN	"	18150L-L0.001	----------
CARBARYL *	"	89305L-L0.01	89308L-L0.004
MALATHION	"	18250L-L0.04	89052L-L0.01
GUTHION	"	18190L-L2.5	89045L-L0.10
2,4,5-T	HERBICIDE	18510L-L0.002	18511L-L0.002
PCB	CONTAMINANT	18164L-L0.005	18177L-L0.005
ADDITIONAL PARAMETERS			
PERCENT CARBON			06076L
PERCENT PARTICLE SIZE	SAND		97281L
"	SILT		97282L
"	CLAY		97283L

* STILL IN USE

TABLE 4.

LOCATION OF WATER, SEDIMENT, AND FISH SAMPLING SITES FOR THE PRINCE EDWARD ISLAND TOXIC SUBSTANCE SURVEY INCLUDING STATION NUMBERS AND MEDIA

	LOCATION	STATION NUMBER	MEDIA
MIDDLETON POND			
1	INFLOW	00PE01CB0041	WATER ONLY
2	OUTFLOW	00PE01CB0042	WATER ONLY
3	UPPER POND	51PE01CB0006	SEDIMENT
4	MID POND	51PE01CB0009	SEDIMENT
5	LOWER POND	51PE01CB0012	SEDIMENT
		90PE01CB0014	FISH
SCALES POND			
6	OUTFLOW 600 M ABOVE DAM	01PE01CB0002	WATER ONLY
7	AT INFLOW	51PE01CB0015	SEDIMENT
8	AT TRIBUTARY	51PE01CB0014	SEDIMENT
9	ABOVE TRIBUTARY	51PE01CB0016	SEDIMENT
		90PE01CB0003	FISH
		90PE01CB0004	FISH



MAP 1. SAMPLING LOCATIONS AT MIDDLETON POND AND SCALES POND

TABLE 5.

METHODS OF SAMPLE PRESERVATION

PARAMETERS	PRESERVATION
SEDIMENTS AND FISH	SAMPLES PLACED IN PREWASHED ALUMINUM CONTAINERS AND FROZEN UNTIL ANALYSIS
WATER:	
METALS	1 ML OF CONCENTRATED NITRIC ACID (ULTREX) PER 500 ML.
ORGANOCHLORINE PEST. ORGANOPHOSPHATE PEST POLYCHLORINATED BIPHENYLS	100 ML OF PESTICIDE QUALITY HEXANE PER 4 LITERS, AND STORE AT 4 DEG.C.
CARBAMATE PEST. PHENOXY HERBICIDES	ADJUST TO PH 3 WITH 50% SULPHURIC ACID, ADD 40 GRAMS SODIUM SULPHATE, AND STORE AT 4 DEG. C.
TRIAZINE HERBICIDES	ADJUST TO PH 8 WITH 0.1M SODIUM HYDROXIDE, ADD 200 ML OF METHYLENE CHLORIDE PER 4 L. STORE AT 4 DEG. C.

TABLE 6.

MAJOR IONS AND NUTRIENTS MEASURED IN WATERS OF THE STUDY AREA

DESCRIPTION	PARAMETER CODE
COLOR	02011L
TURBIDITY	02073L
SPECIFIC CONDUCTANCE	02041L
pH	10301L
RESIDUE NONFILTERABLE	10401L
CALCIUM	20110L
MAGNESIUM	12107L
POTASSIUM	19103L
SODIUM	11103L
SILICA	14102L
ALKALINITY	10101L
CHLORIDE	17205L
SULPHATE	16304L
DISSOLVED ORGANIC CARBON	06107L
NITRATE-NITRITE,NITROGEN	07110L
NITROGEN (TOTAL)	07601L
PHOSPHORUS TOTAL	15413P

MAJOR METALS WITH DETECTION LIMITS (MG/L) MEASURED IN THE STUDY AREA

COPPER	29305P.....L0.002
LEAD	82302P.....L0.002
ZINC	30304P.....L0.01
IRON	26304P.....L0.01
MANGANESE	25304P.....L0.01
ALUMINUM	13305P.....L0.01
CADMIUM	48302P.....L0.001

TABLE 7.

PARAMETER CODES AND DETECTION LIMITS OF
OC PESTICIDES AND PCB'S IN FISH, IN MG/KG.

DESCRIPTION	NAQUADAT PARAMETER CODE	DETECTION LIMIT MG/KG
P,P'-DDT	18602L	L0.001
O,P'-DDT	18606L	L0.001
P,P-DDD	18611L	L0.001
P,P'-DDE	18621L	L0.001
P,P-METHOXYCHLOR	18631L	L0.05
HEPTACHLOR	18641L	L0.001
HEPTACHLOR EPOXIDE	18646L	L0.001
ALPHA ENDOSULPHAN	18651L	L0.001
BETA ENDOSULPHAN	18656L	L0.01
ALPHA CHLORDANE	18661L	L0.005
GAMMA CHLORDANE	18666L	L0.005
BAMMA BHC	18671L	L0.001
ALPHA BHC	18676L	L0.001
MIREX	18629L	L0.001
ALDRIN	18632L	L0.001
ENDRIN	18642L	L0.01
TOTAL AROCHLOR	18169L	L0.005
PERCENT LIPID CONTENT	99506L	------

TABLE 8. (a)

PHYSICAL, MAJOR ION AND NUTRIENT CHEMISTRY AT
SCALE'S POND OUTFLOW

0	DATE	PH	CALCIUM DISS. MG/L	MAGNESIUM DISS. MG/L	POTASSIUM DISS. MG/L	SODIUM DISS. MG/L	SILIC DISS. MG/L	TOTAL MG/L	DISS. MG/L	DISS. MG/L	MG/L
1	27-JUN-85	7.7	24.4	4.5	1.15	5.6	7.0	65.2	9.8	6.6	1.4
2	23-JUL-85	7.8	30.0	6.0	1.05	6.0	5.8	73.0	10.0	6.4	1.3
3	29-AUG-85	7.8	28.0	5.8	1.35	6.4	5.2	76.7	10.4	6.2	0.7
4	30-OCT-85	7.9	30.0	5.8	1.00	6.3	6.6	80.7	10.1	6.9	1.3

0	NITRATE NITRATE MG/L	T.NITROGEN MG/L	T.PHOSPHORUS MG/L	COLOUR REL. UNITS	TURBIDITY JTU	CONDUCTANCE USIE/CM	RESIDUE NONFILTERABLE
1	2.15	2.4	0.053	5	3.0	195	10
2	2.05	2.2	0.037	5	1.9	208	10
3	2.15	2.3	0.035	5	2.2	215	10
4	2.60	2.4		5	1.5	224	

TABLE 8. (b)

PHYSICAL, MAJOR ION AND NUTRIENT CHEMISTRY AT
MIDDLETON POND OUTFLOW

0	DATE	PH	CALCIUM DISS. MG/L	MAGNESIUM DISS. MG/L	POTASSIUM DISS. MG/L	SODIUM DISS. MG/L	SILICA REACTIVE MG/L	ALKALINITY TOTAL MG/L	CHLORIDE DISS. MG/L	SULPHATE DISS. MG/L	DOC MG/L
1	14-MAY-85	7.7	20.0	5.0	0.90	5.0	6.1	52.3	10.2	6.7	3.4
2	15-MAY-85	7.6	22.0	5.2	0.90	5.3	6.5	58.1	10.5	7.0	2.9
3	28-JUN-85	7.7	28.2	5.8	0.90	5.8	7.9	76.5	11.2	7.9	1.9
4	28-AUG-85	8.1	31.0	7.0	0.95	5.8	9.1	83.8	11.7	8.2	0.9
5	30-OCT-85	8.8	32.0	7.8	0.82	6.1	9.0	87.7	11.6	8.2	1.1

0	NITRATE NITRITE MG/L	T.NITROGEN MG/L	T.PHOSPHORUS MG/L	COLOUR REL. UNITS	TURBIDITY JTU	CONDUCTANCE USIE/CM	RESIDUE NONFILTERABLE
1	2.35	2.0	0.043	10	1.5	173	10
2	2.30	2.4	0.049	10	1.6	185	10
3	2.60	2.9	0.065	5	2.7	223	10
4	2.80	2.8	0.100	15	6.8	241	10
5	2.90	3.1		5	1.2	247	

TABLE 8. (c)

PHYSICAL, MAJOR ION AND NUTRIENT CHEMISTRY AT
MIDDLETON POND INFLOW

0	DATE	PH	CALCIUM DISS. MG/L	MAGNESIUM DISS. MG/L	POTASSIUM DISS. MG/L	SODIUM DISS. MG/L	SILICA REACTIVE MG/L	ALKALINITY TOTAL MG/L	CHLORIDE DISS. MG/L	SULPHATE DISS. MG/L	DOC MG/L
1	15-MAY-85	7.7	21.0	5.6	0.85	4.9	6.8	55.2	9.6	7.0	2.5
2	28-JUN-85	7.8	25.4	6.0	0.88	5.4	7.7	74.5	9.5	7.8	1.7
3	24-JUL-85	7.7	35.0	7.8	0.88	5.8	9.4	83.3	11.2	7.8	0.9
4	28-AUG-85	7.3	28.0	7.5	1.10	5.4	9.0	78.2	10.0	8.3	1.0
5	30-OCT-85	8.1	29.0	8.4	0.82	5.6	9.2	86.3	9.5	7.8	0.7

0	NITRATE NITRITE MG/L	T.NITROGEN MG/L	PHOSPHORUS MG/L	COLOUR REL. UNITS	TURBIDITY JTU	CONDUCTANCE USIE/CM	RESIDUE NONFILTERABLE
1	2.52	2.5	0.050	5	0.9	179	10
2	2.40	2.7	0.056	5	2.1	214	10
3	2.90	2.9	0.058	5	0.7	240	10
4	3.25	3.0	0.090	20	8.9	230	23
5	2.80	2.9		5	0.5	233	

TABLE 9.

METALS IN MIDDLETON POND WATER
IN MG/L

0	STATION	DATE	COPPER	LEAD	ZINC	IRON	MANGANESE	ALUMINUM	CADMIUM
1	00PE01CB0042	13-MAY-85	L.002	L.002	L.01	0.24	0.030	0.190	L.001
2	00PE01CB0041	14-MAY-85	L.002	L.002	L.01	0.13	0.010	0.082	L.001
3	00PE01CB0042	14-MAY-85	L.002	L.002	L.01	0.11	0.010	0.082	L.001
4	00PE01CB0041	15-MAY-85	L.002	L.002	L.01	0.08	0.010	0.063	L.001
5	00PE01CB0042	15-MAY-85	L.002	L.002	L.01	0.11	0.010	0.075	L.001
6	00PE01CB0041	28-JUN-85	L.002	L.002	L.01	0.16	0.029	0.050	0.002
7	00PE01CB0042	28-JUN-85	L.002	L.002	L.01	0.26	0.041	0.130	0.001
8	00PE01CB0041	24-JUL-85	L.002	L.002	L.01		L.01	L.01	L.001
9	00PE01CB0042	24-JUL-85	L.002	L.002	L.01		L.01	0.030	L.001
10	00PE01CB0041	28-AUG-85	L.002	L.002	L.01	0.06	0.020	0.050	L.001
11	00PE01CB0042	28-AUG-85	L.002	L.002	L.01	0.16	0.020	0.120	L.001
12	00PE01CB0042	28-AUG-85	L.002	L.002	L.01		L.01	L.010	0.001

TABLE 9.

METALS IN SCALES POND WATER
IN MG/L

0	STATION	SDATE	COPPER	LEAD	ZINC	IRON	MANGANESE	ALUMINUM	CADMUIM
1	01PE01CB0002	27-JUN-85	L.002	L.002	0.01	0.28	0.059	0.070	L.001
2	01PE01CB0002	23-JUL-85	L.002	L.002	L.01	0.04	L.01	0.020	L.001
3	01PE01CB0002	28-AUG-85	L.002	L.002	L.01		L.01	L.010	L.001
4	01PE01CB0002	29-AUG-85	L.002	L.002	L.01	0.31	0.060	0.035	L.001

TABLE 10.

PARTICLE SIZE AND ORGANIC CARBON CONTENT
OF SCALES POND SEDIMENTS:
SUMMARY TABLE

STATION	DATE	PERCENT SAND	PERCENT SILT	PERCENT CLAY	AVERAGE TOC MG/L *	S.D.
51PE01CB0015	14-MAY-85	12.0	61.5	26.5	46000	450
51PE01CB0014	"	44.0	40.8	15.2	25000	830
51PE01CB0016	"	36.5	45.0	18.5	29000	700
51PE01CB0015	23-JUL-85	25.0	50.1	24.9	61000	1100
51PE01CB0014	"	26.0	45.9	28.1	66000	2300
51PE01CB0016	"	32.0	41.1	26.9	38000	1700
51PE01CB0015	29-OCT-85	14.0	57.6	28.4	56000	2600
51PE01CB0016	"	NO SAMPLES ANALYZED				
51PE01CB0014	"	29.0	42.2	28.8	43000 **	4000

NOTES: * N=4
** N=3

TABLE 11..

PARTICLE SIZE AND ORGANIC CARBON CONTENT
OF MIDDLETON POND SEDIMENTS:
SUMMARY TABLE

STATION	DATE	PERCENT SAND	PERCENT SILT	PERCENT CLAY	AVERAGE TOC MG/KG *	S.D.
51PE01CB0006	15-MAY-85	22.0	60.2	17.8	34000	700
51PE01CB0009	"	17.0	61.2	21.8	36000	800
51PE01CB0012	"	3.0	73.6	23.4	40000	1000
51PE01CB0006	24-JUL-85	19.0	63.4	17.6	51000	800
51PE01CB0009	"	20.2	60.6	19.2	48000	1100
51PE01CB0012	"	19.0	60.2	20.8	53000	500
51PE01CB0006	30-OCT-85	14.0	68.8	17.2	47000	1500
51PE01CB0009	"	13.0	67.8	19.2	43000	3000
51PE01CB0012	"	14.0	67.6	18.4	46000	5000

NOTES: * N=4

TABLE 12.

PESTICIDE LEVELS IN WATER AT SCALE'S POND. ALL VALUES ARE IN UG/L.
SPACES WITH NO VALUES DENOTE THAT NO SUCCESFUL ANALYSIS COULD BE COMPLETED

0	SAMPLE	DATE	P,P-DDT	O,P-DDT	P,P-DDD	P,P-DDE	P,P-METHOXY CHLOR	HEPTACHLOR	HEPTACHLOR EPOXIDE	ALPHA-ENDO SULFAN
1	500920	27-JUN-85	0.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
2	501089	23-JUL-85	L.001	L.001	0.001	L.001	0.01	L.001	L.001	L.01
3	501404	29-AUG-85	0.001	L.001	L.001	L.001	L.01	0.001	L.001	L.01
4	501405	29-AUG-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
5	501406	29-AUG-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
6	502023	30-OCT-85								

0	BETA-ENDO SULFAN	ALPHA CHLORDANE	GAMMA CHLORDANE	GAMMA-BHC	ALPHA-BHC	MIREX TOTAL	ALDRIN	ENDRIN	DIELDRIN	PCB TOTAL
1	L.01	L.005	L.005	L.001	0.001	L.001	L.001	L.01	L.001	L.005
2	L.01	L.005	L.005	L.001	0.002	0.002	L.001	L.01	L.001	L.005
3	L.01	L.005	L.005	0.001	L.001	0.001	L.005	L.01	L.001	L.005
4	L.01	L.005	L.005	L.001	0.001	0.001	L.001	L.01	L.001	L.005
5	L.01	L.005	L.005	0.001	0.001	0.006	L.001	L.01	L.001	L.005
6										

0	2,4-D	2,4,5-T	MALATHION	GUTHION	PHORATE	ATRAZINE	ALDICARB	ALDICARB SULFOXIDE	ALDICARB SULFONE	CARBARYL
1	L.004	L.002	L.04	L2.5	L.02	0.014	L.01	L.01	L.01	L.01
2	L.004	L.002	L.04	L2.5	L.02	0.013	L.02	L.02	L.03	L.01
3	L.004	L.002	L.04	L2.5	L.02	0.013	L.02	L.02	L.03	L.01
4	L.004	L.002	L.04	L2.5	L.02	0.015	L.02	L.02	L.03	L.01
5	L.004	L.002	L.04	L2.5	L.02	0.015	L.02	L.02	L.03	L.01
6	L.004	L.002				0.013	L3.0	L3.0	L3.0	L3.0

0	CHLORFEN-VINPHOS	DIAZINON	DISYSTON	METHIDA-THION	METRIBUZINE	CARBOFURAN
1	L.04			L.1		L.01
2	L.04	L.02	L.02	L.1	L.016	L.01
3	L.04	L.02	L.02	L.1	L.016	L.01
4	L.04	L.02	L.02	L.1	L.016	L.01
5	L.04	L.02	L.02	L.1	L.016	L.01
6						

TABLE 13.

PESTICIDE LEVELS IN WATER AT THE UPPER MIDDLETON POND SITE.
ALL VALUES ARE IN UG/L. SPACES WITH NO VALUES DENOTE THAT NO SUCCESFUL ANALYSIS COULD BE COMPLETED

0	SAMPLE	DATE	P,P-DDT	O,P-DDT	P,P-DDD	P,P-DDE	P,P-METHOXY-CHLOR	HEPTACHLOR	HEPTACHLOR EPOXIDE	ALPHA-ENDO SULFAN
1	500344	13-MAY-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
2	500345	14-MAY-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
3	500346	14-MAY-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
4	500347	14-MAY-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
5	500348	15-MAY-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
6	500921	28-JUN-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
7	501090	24-JUL-85	0.002	L.001	L.001	L.001	L.01	0.002	L.001	L.01
8	501397	28-AUG-85	0.002	L.001	0.002	L.001	L.01	L.001	L.001	L.01
9	501398	28-AUG-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
10	502024	30-OCT-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01

0	BETA-ENDO SULFAN	ALPHA CHLORDANE	GAMMA CHLORDANE	GAMMA-BHC	ALPHA-BHC	MIREX	ALDRIN	ENDRIN	DIELDRIN	PCB TOTAL
1	L.01	L.005	L.005	L.001	L.001	L.001	L.001	L.01	L.001	L.005
2	L.01	L.005	L.005		L.001	L.001	L.001	L.01	L.005	L.005
3	L.01	L.005	L.005		L.001	L.001	L.001	L.01	L.001	L.005
4	L.01	L.005	L.005		L.001	L.001	L.001	L.01	L.001	L.005
5	L.01	L.005	L.005	L.001	L.001	L.001	L.001	L.01	L.001	L.005
6	L.01	L.005	L.005	L.001	L.001	0.001	L.001	L.01	L.001	L.005
7	L.01	L.005	L.005	L.001	0.001	L.001	L.001	L.01	L.001	L.005
8	L.01	L.005	L.005	L.001	L.001	0.005	L.001	L.01	L.001	L.005
9	L.01	L.005	L.005	L.001	L.001	0.001	L.001	L.01	L.001	L.005
10	L.01	L.005	L.005	L.001	L.001	L.001	L.001	L.01	L.001	L.005

0	2,4-D	2,4,5-T	MALATHION	GUTHION	PHORATE	ATRAZINE	ALDICARB	ALDICARB SULFOXIDE	ALDICARB SULFONE	CARBARYL
1	L.004	L.002	L.08		L.04	L.02				L.2
2	L.004	L.002	L.08		L.04	L.02				L.2
3	L.004	L.002	L.08		L.04	L.02				L.2
4	L.004	L.002	L.08		L.04	L.02				L.2
5	L.004	L.002	L.08		L.04	L.02				L.2
6	L.004	L.002	L.04	L2.5	L.02	0.013	L.01	L.01	L.01	L.01
7	L.004	L.002	L.04	L2.5	L.02	0.015	L.02	L.02	L.03	L.01
8	L.004	L.002	L.04	L2.5	L.02	0.017	L.02	L.02	L.03	L.01
9	L.004	L.002	L.04	L2.5	L.02		L.02	L.02	L.03	L.01
10	L.004	L.002	L.002	L.001	L.001	0.015	L3.0	L3.0	L3.0	L3.0

PESTICIDE LEVELS IN WATER AT THE UPPER MIDDLETON POND SITE.
ALL VALUES ARE IN UG/L. SPACES WITH NO VALUES DENOTE THAT NO SUCCESFUL ANALYSIS COULD BE COMPLETED

0	CHLORFEN-VINPHOS	DIAZINON	DISYSTON	METHIDA-THION	METRIBUZINE	CARBOFURAN
1	L.03	L.04	L.04	L.04	L.04	L.12
2	L.03	L.04	L.04	L.04	L.04	L.12
3	L.03	L.04	L.04	L.04	L.04	L.12
4	L.03	L.04	L.04	L.04	L.04	L.12
5	L.03	L.04	L.04	L.04	L.04	L.12
6	L.04			L.1		L.01
7	L.04	L.02	L.02	L.1	L.016	L.01
8	L.04	L.02	L.02	L.1	L.016	L.01
9	L.04	L.02	L.02	L.1		L.01
10	L.003	L.001	L.001	L.002	L.016	L3.0

TABLE 14.

PESTICIDE LEVELS IN WATER AT THE LOWER MIDDLETON POND SITE.
ALL VALUES ARE IN UG/L.SPACES WITH NO VALUES DENOTE THAT NO
SUCCESFUL ANALYSIS COULD BE COMPLETED

0	SAMPLE	DATE	P,P-DDT	O,P-DDT	P,P-DDD	P,P-DDE	P,P-METHOXY-CHLOR	HEPTACHLOR	HEPTACHLOR EPOXIDE	ALPHA-ENDO SULFAN
1	500334	13-MAY-85	L.001	L.001	L.001		L.01	L.001	L.001	L.01
2	500335	13-MAY-85	L.001	L.001	L.001		L.01	L.001	L.001	L.01
3	500333	13-MAY-85	L.001	L.001	L.001		L.01	L.001	L.001	L.01
4	500336	14-MAY-85	L.00	L.001	L.001	L.001	L.01	L.001	L.001	L.01
5	500337	15-MAY-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
6	500922	28-JUN-85	0.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01
7	500923	28-JUN-85	0.002	L.001	L.001	L.001	L.01	L.001	L.001	L.01
8	500924	28-JUN-85	L.001	L.001	L.001	0.001	L.01	0.001	L.001	L.01
9	501091	24-JUL-85	0.003	L.001	L.001	L.001	L.01	0.002	L.001	L.01
10	501092	24-JUL-85	L.001	L.001	L.001	L.001	L.01	0.001	L.001	L.01
11	501093	24-JUL-85	L.001	L.001	L.001	0.001	L.01	L.001	L.001	L.01
12	501399	28-AUG-85	0.002	L.001	L.001	0.001	L.01	0.001	L.001	L.01
13	502025	30-OCT-85	L.001	L.001	L.001	L.001	L.01	L.001	L.001	L.01

0	BETA-ENDO SULFAN	ALPHA CHLORDANE	GAMMA CHLORDANE	GAMMA-BHC	ALPHA-BHC	MIREX	ALDRIN	ENDRIN	DIELDRIN	PCB TOTAL
1	L.01	L.005	L.005	L.001		L.001	L.001	L.01	L.001	L.005
2	L.01	L.005	L.005	L.001		L.001	L.001	L.01	L.001	L.005
3	L.01	L.005	L.005	L.001		L.001	L.001	L.01	L.001	L.005
4	L.01	L.005	L.005	L.001		L.001	L.001	L.01	L.001	L.005
5	L.01	L.005	L.005	L.001	L.001	L.001	L.001	L.01	L.001	L.005
6	L.01	L.005	L.005	L.001	L.001	L.001	L.001	L.01	L.001	L.005
7	L.01	L.005	L.005	L.001	L.001	0.004	L.001	L.01	L.001	L.005
8	L.01	L.005	L.005	L.001	L.001	L.001	L.001	L.01	L.001	L.005
9	L.01	L.005	L.005	L.001	L.001	0.002	L.001	L.01	L.001	L.005
10	L.01	L.005	L.005	L.001	L.001	0.001	L.001	L.01	L.001	L.005
11	L.01	L.005	L.005	L.001	L.001	0.002	L.001	0.08	L.001	L.005
12	L.01	L.005	L.005	L.001	0.001	0.001	L.001	L.01	L.001	L.005
13	L.01	L.005	L.005	L.001	L.001	L.001	L.001	L.01	L.001	L.005

PESTICIDE LEVELS IN WATER AT THE LOWER MIDDLETON POND SITE.
ALL VALUES ARE IN UG/L.SPACES WITH NO VALUES DENOTE THAT NO
SUCCESFUL ANALYSIS COULD BE COMPLETED

0	2,4-D	2,4,5-T	MALATHION	GUTHION	PHORATE	ATRAZINE	ALDICARB	ALDICARB SULFOXIDE	ALDICARB SULFONE	CARBARYL
1	L.004	L.002	L.08		L.04	L.02				L.2
2	L.004	L.002	L.08		L.04	L.02				L.2
3	L.004	L.002	L.08		L.04	L.02				L.2
4	L.004	L.002	L.08		L.04	L.02				L.2
5	L.004	L.002	L.08		L.04	L.02				L.2
6	L.004	L.002	L.04	L2.5	L.02	L.008	L.01	L.01	L.01	L.01
7	L.004	L.002	L.04	L2.5	L.02	L.008	L.01	L.01	L.01	L.01
8	L.004	L.002	L.04	L2.5	L.02	L.008	L.01	L.01	L.01	L.01
9	L.004	L.002	L.04	L2.5	L.02	0.013	L.02	L.02	L.03	L.01
10	L.004	L.002	L.04	L2.5	L.02	0.013	L.02	L.02	L.03	L.01
11	L.004	L.002	L.04	L2.5	L.02	L.005	L.02	L.02	L.03	L.01
12	L.004	L.002	L.04	L2.5	L.02	L.008	L.02	L.02	L.03	L.01
13	L.004	L.002	L.002	L.001	L.001	0.011	L3.0	L3.0	L3.0	L3.0

0	CHLORFEN-VINPHOS	DIAZINON	DISYSTON	METHIDA-THION	METRIBUZINE	CARBOFURAN
1	L.03	L.04	L.04	L.04	L.04	L.12
2	L.03	L.04	L.04	L.04	L.04	L.12
3	L.03	L.04	L.04	L.04	L.04	L.01
4	L.03	L.04	L.04	L.04	L.04	L.12
5	L.03	L.04	L.04	L.04	L.04	L.12
6	L.04			L.1		L.01
7	L.04			L.1		L.01
8	L.04			L.1		L.01
9	L.04	L.02	L.02	L.1	L.016	L.01
10	L.04	L.02	L.02	L.1	L.016	L.01
11	L.04	L.02	L.02	L.1	L.016	L.01
12	L.04	L.02	L.02	L.1	L.016	L.01
13	L.003	L.001	L.001	L.002	L.016	L3.0

TABLE 15.

PESTICIDE LEVELS IN SCALES POND SEDIMENTS IN MG/KG

0	STATION	DATE	P,P-DDT	O,P-DDT	P,P'-DDD	P,P-DDE	ALPHA-ENDO SULPHAN	BETA-ENDO SULPHAN	TOTAL DDT SUBSTRATES
1	51PE01CB0015	14-MAY-85	0.085	0.011	0.017	0.046	0.005	L.01	0.159
2	51PE01CB0015	14-MAY-85	0.080	0.008	0.015	0.037	0.004	L.01	0.140
3	51PE01CB0015	14-MAY-85	0.058	0.008	0.013	0.032	0.003	L.01	0.111
4	51PE01CB0014	14-MAY-85	0.089	0.010	0.025	0.035	0.001	L.01	0.159
5	51PE01CB0014	14-MAY-85	0.080	0.012	0.031	0.042	0.001	L.01	0.165
6	51PE01CB0014	14-MAY-85	0.070	0.010	0.026	0.036	0.001	L.01	0.142
7	51PE01CB0016	14-MAY-85	0.030	0.004	0.009	0.021	0.001	L.01	0.064
8	51PE01CB0016	14-MAY-85	0.041	0.005	0.013	0.026	0.003	L.01	0.085
9	51PE01CB0016	14-MAY-85	0.019	0.003	0.007	0.012	0.001	L.01	0.041
10	51PE01CB0015	27-JUN-85	0.060	0.008	0.017	0.040	L.001	0.01	0.125
11	51PE01CB0015	27-JUN-85	0.078	0.008	0.017	0.041	0.001	L.01	0.144
12	51PE01CB0015	27-JUN-85	0.058	0.008	0.016	0.039	0.001	L.01	0.121
13	51PE01CB0014	27-JUN-85	0.092	0.018	0.059	0.065	0.001	L.01	0.234
14	51PE01CB0014	27-JUN-85	0.089	0.017	0.061	0.065	0.001	L.01	0.232
15	51PE01CB0014	27-JUN-85	0.090	0.020	0.063	0.065	0.002	L.01	0.238
16	51PE01CB0016	27-JUN-85	0.036	0.005	0.010	0.025	L.01	L.01	0.076
17	51PE01CB0016	27-JUN-85	0.014	0.002	0.005	0.011	L.01	L.01	0.032
18	51PE01CB0015	23-JUL-85	0.049	0.007	0.016	0.044	0.003	L.01	0.116
19	51PE01CB0015	23-JUL-85	0.048	0.007	0.017	0.046	0.003	L.01	0.119
20	51PE01CB0015	23-JUL-85	0.062	0.008	0.017	0.046	0.003	L.01	0.133
21	51PE01CB0014	23-JUL-85	0.160	0.029	0.086	0.100	0.004	L.01	0.375
22	51PE01CB0014	23-JUL-85	0.170	0.033	0.100	0.110	0.004	L.01	0.413
23	51PE01CB0014	23-JUL-85	0.150	0.026	0.096	0.110	0.004	L.01	0.382
24	51PE01CB0016	23-JUL-85	0.041	0.005	0.012	0.025	0.002	L.01	0.083
25	51PE01CB0016	23-JUL-85	0.035	0.005	0.015	0.034	0.002	L.01	0.089
26	51PE01CB0016	23-JUL-85	0.040	0.006	0.013	0.030	0.002	L.01	0.089
27	51PE01CB0015	29-AUG-85	0.072	0.011	0.021	0.055	0.002	L.01	0.159
28	51PE01CB0015	29-AUG-85	0.084	0.009	0.023	0.060	0.002	L.01	0.176
29	51PE01CB0015	29-AUG-85	0.088	0.009	0.022	0.060	0.003	L.01	0.179
30	51PE01CB0014	29-AUG-85	0.140	0.025	0.097	0.100	0.003	L.01	0.362
31	51PE01CB0014	29-AUG-85	0.140	0.023	0.087	0.100	0.003	L.01	0.350
32	51PE01CB0014	29-AUG-85	0.140	0.024	0.090	0.100	0.002	L.01	0.354
33	51PE01CB0016	29-AUG-85	0.035	0.005	0.016	0.024	0.001	L.01	0.080
34	51PE01CB0016	29-AUG-85	0.031	0.005	0.015	0.023	0.001	L.01	0.074
35	51PE01CB0016	29-AUG-85	0.024	0.004	0.012	0.017	0.001	L.01	0.057
36	51PE01CB0015	29-OCT-85	0.085	0.010	0.026	0.065	0.002	L.01	0.186
37	51PE01CB0015	29-OCT-85	0.080	0.010	0.025	0.060	0.002	L.01	0.175
38	51PE01CB0015	29-OCT-85	0.086	0.009	0.024	0.060	0.002	L.01	0.179
39	51PE01CB0014	29-OCT-85	0.130	0.023	0.084	0.090	L.001	L.01	0.327
40	51PE01CB0014	29-OCT-85	0.120	0.023	0.081	0.090	0.001	L.01	0.314
41	51PE01CB0014	29-OCT-85	0.120	0.024	0.088	0.090	L.001	L.01	0.322
42	51PE01CB0016	29-OCT-85	0.074	0.007	0.023	0.046	0.002	L.01	0.150
43	51PE01CB0016	29-OCT-85	0.050	0.006	0.023	0.046	0.002	L.01	0.125

THE FOLLOWING WERE LESS THAN THEIR DETECTION LIMITS AS PER TABLES 2 AND 3:
P,P-METHOXYCHLOR, HEPTACHLOR, HEPTACHLOR EPOXIDE, BETA-ENDOSULPHAN, ALPHA-CHLORDANE, GAMMA-CHLORDANE, LINDANE, ALPHA-BHC, MIREX, ALDRIN, ENDRIN, TOTAL AROCHLOR, 2,4-D, 2,4,5-T, GUTHION, PHORATE,CARBOFURAN, ATRAZINE, CHLOROFENVINPHOS, METHIDATHION, PIRIMICARB, ALDICARB, ALDICARB SULFONE, ALDICARB SULFOXIDE, CARBARYL, AND MALATHION

TABLE 16.

PESTICIDES IN MIDDLETON POND SEDIMENTS IN MG/KG

0	STATION	DATE	P,P-DDT	O,P-DDT	P,P'-DDD	P,P-DDE	ALPHA-ENDOSULPHAN	TOTAL DDT-SUBSTRATES
1	51PE01CB0006	15-MAY-85	0.066	0.008	0.022	0.035	L.001	0.131
2	51PE01CB0006	15-MAY-85	0.077	0.011	0.024	0.041	0.001	0.153
3	51PE01CB0006	15-MAY-85	0.071	0.008	0.018	0.033	0.001	0.130
4	51PE01CB0009	15-MAY-85	0.073	0.012	0.024	0.046	0.002	0.155
5	51PE01CB0009	15-MAY-85	0.012	0.002	0.005	0.008	L.01	0.027
6	51PE01CB0009	15-MAY-85	0.055	0.009	0.016	0.030	0.001	0.110
7	51PE01CB0012	15-MAY-85	0.078	0.012	0.023	0.045	0.002	0.158
8	51PE01CB0012	15-MAY-85	0.075	0.013	0.024	0.048	0.002	0.160
9	51PE01CB0012	15-MAY-85	0.076	0.012	0.023	0.047	0.002	0.158
10	51PE01CB0006	28-JUN-85	0.036	0.004	0.020	0.031	L.001	0.091
11	51FE01CB0006	28-JUN-85	0.055	0.006	0.017	0.029	L.001	0.107
12	51PE01CB0006	28-JUN-85	0.045	0.006	0.016	0.028	L.001	0.095
13	51PE01CB0012	28-JUN-85	0.070	0.011	0.024	0.048	0.002	0.153
14	51PE01CB0012	28-JUN-85	0.072	0.009	0.020	0.042	0.001	0.143
15	51PE01CB0012	28-JUN-85	0.072	0.009	0.026	0.047	0.002	0.154
16	51PE01CB0006	24-JUL-85	0.079	0.010	0.024	0.043	0.001	0.156
17	51PE01CB0006	24-JUL-85	0.099	0.012	0.027	0.049	0.001	0.187
18	51PE01CB0006	24-JUL-85	0.083	0.013	0.024	0.045	0.001	0.165
19	51PE01CB0009	24-JUL-85	0.100	0.011	0.027	0.050	0.002	0.188
20	51PE01CB0009	24-JUL-85	0.100	0.010	0.034	0.065	0.002	0.209
21	51PE01CB0009	24-JUL-85	0.087	0.011	0.035	0.065	0.002	0.198
22	51PE01CB0012	24-JUL-85	0.120	0.013	0.032	0.065	0.002	Q.230
23	51PE01CB0012	24-JUL-85	0.110	0.014	0.035	0.070	0.002	0.229
24	51PE01CB0012	24-JUL-85	0.100	0.013	0.042	0.070	0.001	0.225
25	51PE01CB0009	28-JUL-85	0.050	0.007	0.020	0.041	0.001	0.118
26	51PE01CB0009	28-JUL-85	0.064	0.009	0.019	0.040	0.002	0.132
27	51PE01CB0009	28-JUL-85	0.066	0.009	0.020	0.044	0.002	0.139
28	51PE01CB0006	28-AUG-85	0.057	0.008	0.020	0.041	0.001	0.126
29	51PE01CB0006	28-AUG-85	0.048	0.007	0.018	0.032	0.001	0.105
30	51PE01CB0006	28-AUG-85	0.050	0.009	0.019	0.035	0.001	0.113
31	51PE01CB0009	28-AUG-85	0.097	0.010	0.023	0.046	0.001	0.176
32	51PE01CB0009	28-AUG-85	0.089	0.013	0.024	0.048	0.001	0.174
33	51PE01CB0009	28-AUG-85	0.088	0.011	0.026	0.050	0.002	0.175
34	51PE01CB0012	28-AUG-85	0.094	0.012	0.028	0.055	0.002	0.189
35	51PE01CB0012	28-AUG-85	0.089	0.012	0.028	0.055	0.002	0.184
36	51PE01CB0012	28-AUG-85	0.100	0.013	0.033	0.060	0.002	0.206
37	51PE01CB0006	30-OCT-85	0.082	0.006	0.022	0.040	L.001	0.150
38	51PE01CB0006	30-OCT-85	0.050	0.007	0.021	0.030	L.001	0.116
39	51PE01CB0006	30-OCT-85	0.046	0.006	0.020	0.039	L.001	0.111
40	51PE01CB0009	30-OCT-85	0.088	0.009	0.025	0.050	L.001	0.172
41	51PE01CB0009	30-OCT-85	0.068	0.009	0.024	0.046	L.001	0.147
42	51PE01CB0009	30-OCT-85	0.079	0.015	0.022	0.041	L.001	0.157
43	51PE01CB0012	30-OCT-85	0.086	0.011	0.030	0.060	L.001	0.187
44	51PE01CB0012	30-OCT-85	0.080	0.010	0.027	0.050	L.001	0.167
45	51PE01CB0012	30-OCT-85	0.083	0.011	0.028	0.055	L.001	0.177

THE FOLLOWING WERE NOT DETECTED AS PER DETECTION LIMITS IN TABLES 2 AND 3:
P,P-METHOXYCHLOR, HEPTACHLOR, HEPTACHLOR EPOXIDE, BETTA-ENDOSULPHAN, ALPHA-CHLORDANE, GAMMA-CHLORDANE, LINDANE, ALPHA-BHC, MIREX, ALDRIN, ENDRIN, TOTAL AROCHLOR, 2,4-D, 2,4,5-T, GUTHION, PHORATE, CARBOFURAN, ATRAZINE, CHLOROFENVINPHOS, METHIDATHION, PIRIMICARB, ALDICARB, ALDICARB SULFONE,

TABLE 17.

PESTICIDES IN FISH FROM SCALES POND
IN MG/KG

0	STATION	DATE	P,P'-DDT	O,P'-DDT	P,P-DDD	P,P'-DDE	ALPHA ENSOSULPHAN	PERCENT LIPID
1	90PE01CB0004	15-MAY-85	0.120	0.023	0.008	0.13	L.001	10.16
2	90PE01CB0003	15-MAY-85	0.067	0.016	0.004	0.12	L.001	4.19
3	90PE01CB0004	15-JUL-85	0.035	0.007	0.008	0.11	L.001	4.80
4	90PE01CB0003	15-JUL-85	0.051	0.010	0.009	0.11	L.001	5.01
5	90PE01CB0003	15-JUL-85	0.039	0.008	0.007	0.11	L.001	4.44
6	90PE01CB0003	29-AUG-85	0.011	0.002	0.007	0.10	L.001	7.04
7	90PE01CB0003	30-OCT-85	0.013	0.003	0.003	0.09	0.001	5.92

THE FOLLOWING WERE NOT DETECTED AS PER DETECTION LIMITS IN TABLE 7:

P,P-METHOXYCHLOR, HEPTACHLOR, HEPTACHLOR EPOXIDE, BETA-ENDOSULPHAN, ALPHA-CHLORDANE, GAMMA-CHLORDANE, ALPHA-BHC, GAMMA-BHC, MIREX, ALDRIN, ENDRIN, AND TOTAL AROCHLORS.

TABLE 18.

PESTICIDES IN FISH FROM MIDDLETON POND
IN MG/KG

0	STATION	DATE	P,P'-DDT	O,P'-DDT	P,P-DDD	P,P'-DDE	PERCENT LIPID
1	90PE01CB0014	15-MAY-85	0.090	0.020	0.016	0.15	5.28
2	90PE01CB0014	15-JUL-85	0.079	0.015	0.011	0.14	3.89
3	90PE01CB0014	23-AUG-85	0.052	0.010	0.021	0.14	9.63
4	90PE01CB0014	28-AUG-85	0.055	0.011	0.016	0.14	4.37

THE SAME PARAMETERS WERE NOT DETECTED IN MIDDLETON POND FISH AS THOSE FOR SCALES POND GIVEN IN THE PRECEEDING TABLE (TABLE 17.).

TABLE 19.

SPIKING RECOVERIES FOR WATER IN P.E.I. STUDY

SPIKE # DATE	P,P-DDT 18000L	O,P-DDT 18005L	P,P-DDD 18010L	P,P-DDE 18020L	P,P-METHOXYCHLOR 18030L	HEPTACHLOR 18040L	HEPTACHLOREPOX 18045L	A-ENDOSULFAN 18050L
1 FIELD 1	120.0	66.0	68.0	73.0	68.0	104.0	84.0	58.0
2 FIELD2MAY	108.0	64.0	66.0	73.0	69.0	100.0	80.0	54.0
3 FIELD3MAY	110.0	60.0	62.0	160.0	73.0	92.0	52.0	54.0
4 LAB1MAY	124.0	72.0	72.0	87.0	80.0	116.0	104.0	62.0
5 LAB2MAY	122.0	68.0	72.0	80.0	86.0	104.0	84.0	62.0
6 LAB3MAY	104.0	62.0	68.0	73.0	80.0	96.0	76.0	54.0
7 FIELDJUNE	110.0	220.0	44.0	420.0	10.0	88.0	132.0	77.0
8 FIELDJULY								
9 FIELDAUG	140.0	50.0	108.0	566.5	175.0	1420.0	104.0	96.0
10 FIELD1OCT	108.0	80.0	88.0	173.0	120.0	104.0	104.0	308.0
11 FIELD2OCT	112.0	80.0	88.0	160.0	100.0	96.0	160.0	307.0
12 FIELD3OCT	80.0	64.0	68.0	120.0	80.0	80.0	56.0	38.0
13								
14 MEAN	112.6	80.5	73.1	180.5	85.5	218.2	94.2	106.4
15 STAN.DEV.	14.9	47.0	16.6	162.6	39.9	398.7	31.7	100.5
16								
17 MEAN WITH-								
18 OUT AUGUST	109.8	83.6	69.6	141.9	76.6	98.0	93.2	107.4
19 STAN.DEV.	12.4	48.4	12.6	105.7	28.2	10.0	33.2	105.9

SPIKE # DATE	B-ENDOSULFAN 18055L	A-CHLORDANE 18060L	G-CHLORDANE 18065L	G-BHC 18070L	A-BHC 18075L	MIREX 18125L	ALDRIN 18130L	ENDRIN 18140L	DIELDRIN 18150L
1 FIELD 1	68.0	80.0	119.0	76.0	100.0	63.0	115.0	52.0	65.0
2 FIELD2MAY	64.0	76.0	119.0	84.0	96.0	43.0	104.0	52.0	65.0
3 FIELD3MAY	60.0	68.0	108.0	56.0	92.0	71.0	100.0	48.0	62.0
4 LAB1MAY	70.0	88.0	131.0	88.0	112.0	54.0	127.0	58.0	73.0
5 LAB2MAY	70.0	80.0	123.0	88.0	108.0	49.0	111.0	54.0	69.0
6 LAB3MAY	66.0	95.0	112.0	76.0	84.0	45.0	88.0	50.0	65.0
7 FIELDJUNE	80.0	96.0	127.0	68.0	68.0	74.0	138.0	80.0	54.0
8 FIELDJULY									
9 FIELDAUG	100.0	150.0	115.5	120.0	114.0	79.0	192.5	100.0	192.5
10 FIELD1OCT	60.0	216.0	93.0	88.0	64.0	82.0	154.0	80.0	123.0
11 FIELD2OCT	40.0	216.0	85.0	87.0	64.0	82.0	161.0	80.0	123.0
12 FIELD3OCT	40.0	152.0	69.0	69.0	56.0	66.0	138.0	60.0	92.0
13									
14 MEAN	65.3	119.7	109.2	81.8	87.1	64.4	129.9	64.9	89.4
15 STAN.DEV.	16.8	55.2	19.2	16.4	21.1	14.7	30.8	17.2	41.7
16									
17 MEAN WITH-									
18 OUT AUGUST	61.8	116.7	108.6	78.0	84.4	62.9	123.6	61.4	79.1
19 STAN.DEV.	12.8	57.2	20.1	11.0	20.2	14.6	24.0	13.3	25.1

SPIKING RECOVERIES FOR WATER IN P.E.I. STUDY

SPIKE # DATE	PCB 18164L	2,4-D 18500L	2,4,5-T 18510L	MALATHION 18250L	GUTHION 18190L	PHORATE 18300L	CARBARYL 89305L	ATRAZINE 89802L
1 FIELD 1	70.0	60.0	86.0	76.0		95.0	17.0	
2 FIELD2MAY	85.0	60.0	76.0	86.0		83.0	19.0	
3 FIELD3MAY	75.0	60.0	70.0	82.0		79.0	19.0	
4 LAB1MAY	75.0	46.0	80.0	84.0		79.0	15.0	123.0
5 LAB2MAY	120.0	136.0	100.0	88.0		80.0	15.0	93.0
6 LAB3MAY	107.0	150.0	96.0	86.0		80.0	15.0	100,0
7 FIELDJUNE	90.0	7.0	7.0		96.0	60.0	100.0	4.0
8 FIELDJULY		10.0	1.0				56.0	
9 FIELDAUG	145.0	76.0	60.0				92.0	51.5
10 FIELD1OCT	60.0	32.0	60.0	50.0	80.0	94.0	120.0	130.0
11 FIELD2OCT	70.0	46.0	64.0	40.0	56.0	84.0	120.0	90.0
12 FIELD3OCT	50.0	30.0	48.0	22.0	33.0	84.0		97.0
13								
14 MEAN	86.1	59.4	62.3	68.2	66.3	81.8	53.5	86.1
15 STAN.DEV.	28.0	44.2	31.2	24.5	27.6	9.6	45.5	40.7
16								
17 MEAN WITH-		57.9	62.5	68.2	66.3	81.8	49.6	91.0
18 OUT AUGUST	80.2	46.1	32.7	24.5	27.6	9.6	46.0	41.3
19 STAN.DEV.	21.1							

TABLE 20.

FIELD SPIKE RECOVERIES FOR SEDIMENTS
BLANK INDICATES INTERFERENCE OR NOT SPIKED

0	STATION	DATE	P,P-DDT	O,P-DDT	P,P'-DDD	P,P-DDE	HEPTACHLOR	HEPTACHLOR EPOXIDE	ALPHA-ENDOSULPHAN	BETA-ENDOSULPHAN
1	MIDDLETON C	15-MAY-85	104	77	63	119	289	78	51	10
2	MIDDLETON C	15-MAY-85	104	87	93	185	327	78	51	20
3	MIDDLETON C	15-MAY-85	134	87	93	219	346	78	79	10
4	MIDDLETON C	28-JUN-85	116	82	70	194	250	118	58	10
5	MIDDLETON C	28-JUN-85	126	92	80	194	270	137	78	10
6	MIDDLETON A	24-JUL-85	1	39	19	23	269	39	49	10
7	MIDDLETON A	24-JUL-85	121	79	69	135	269	137	65	10
8	SCALES POND	29-AUG-85	1	87	59		307	78	67	10
9	SCALES POND	29-AUG-85		77	59		307	98	48	10

0	11 ALPHA-CHLORDANE	12 GAMMA-CHLORDANE	13 LINDANE	14 ALPHA-BHC	15 MIREX	16 ALDRIN	17 ENDRIN	18 TOTAL AROCHLOR	19 2,4-D	20 2,4,5-T
1	140	96	80	100	92	77	20	102	120	70
2	140	96	80	120	105	77	30	110	60	140
3	140	96	100	120	105	77	50	115	120	140
4	100	58	80	80	79	77	20	95		
5	160	96	80	100	85	77	20	95		
6	100	58	60	60	66	58	20	70		
7	120	77	80	100	85	77	20	90	40	30
8	120	96	80	100	92	58	20	100		
9	120	77	80	100	85	58	20	97		

0	21 MALATHION	22 PHORATE	23 CARBO FURAN	24 ATRAZINE	25 PIRIMI CARB	26 ALDICARB	27 ALDICARB SULFOXIDE	28 ALDICARB SULFONE	29 CARBARYL
1	76	76	8	112	0	0	0	0	8
2	78	90	8	92	0	0	0	0	8
3	76	82	8	104	0	0	0	0	8
4	66	44	6		0	0	0	30	6
5	64	46	10		0	0	0	30	8
6	0	0							
7	0	0							
8	0	0							
9	0	0	10		0	0	0	30	8

TABLE 21.

LABORATORY SPIKE RECOVERIES FOR ATRAZINE IN PERCENT
IN SEDIMENTS

0	STATION	DATE	ATRAZINE
1	51PE01CBLS12	28-JUN-85	93
2	51PE01CBLS12	28-JUN-85	105
3	51PE01CBLS12	28-JUN-85	96
4	51PE01CBLS12	28-JUN-85	75
5	51PE01CBLS06	24-JUL-85	94
6	51PE01CBLS06	24-JUL-85	84
7	51PE01CBLS06	24-JUL-85	84
8	51PE01CBLS15	29-AUG-85	81
9	51PE01CBLS15	29-AUG-85	97
10	51PE01CBLS15	29-AUG-85	81

TABLE 22.

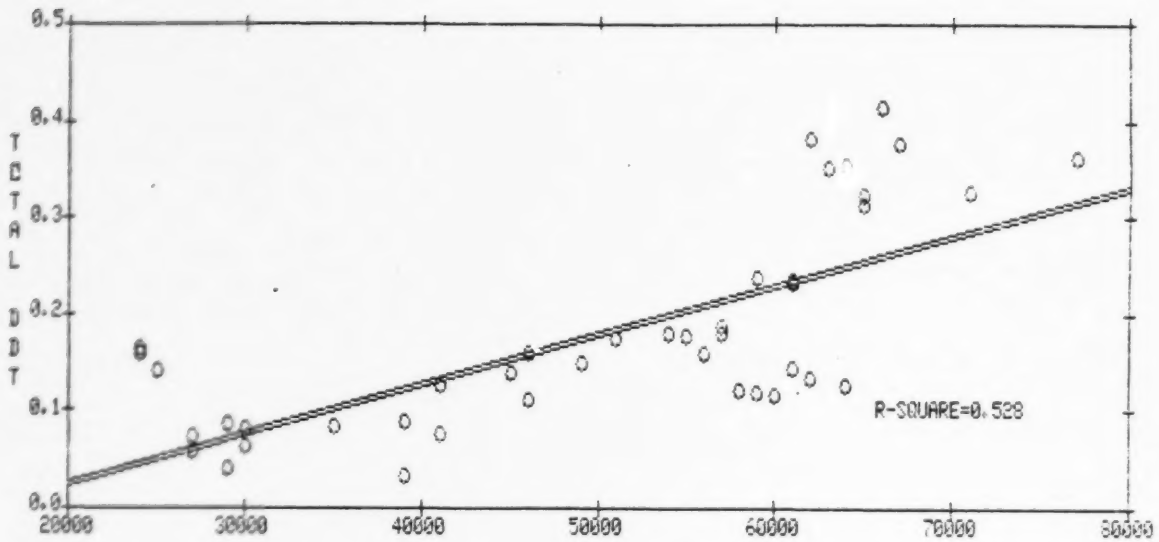
SEDIMENT TOXICITY TESTING

SAMPLING DATE	LOCATION	MICROTOX 15 MIN (EC-50)	SPIRILLUM-VOLUTANS 120 MIN	140 MIN	GENO-TOXICITY (SOSIP)
27-JUNE	SCALES ABOVE DAM	N.D.	N.D.	N.D.	N.D.
27-JUNE	" AT TRIB.	N.D.	N.D.	N.D.	N.D.
27-JUNE	" ABOVE TRIB.	N.D.	N.D.	+	N.D.
28-JUNE	MIDDLETON "A"	N.D.	N.D.	N.D.	N.D.
28-JUNE	" "B"	N.D.	N.D.	N.D.	+
15-SEPT	SCALES ABOVE DAM	44.4%	--	--	0.64
15-SEPT	" AT TRIB	N.D.	--	--	0.28
15-SEPT	" 15KM ABOVE DAM	N.D.	--	--	0.31
15-SEPT	MIDDLETON "A"	N.D.	--	--	0.42
15-SEPT	" "B"	N.D.	--	--	0.15
15-SEPT	" "C"	N.D.	--	--	0.17
NEGATIVE CONTROL (DH2O)		N.D.	--	--	N.D.

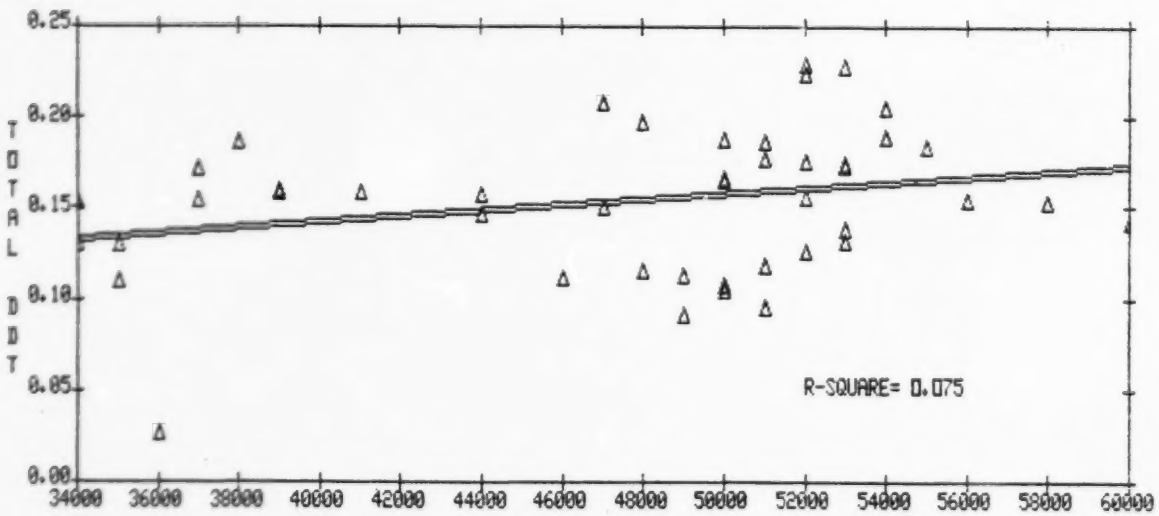
N.D. = NOT DETECTED
-- = TEST NOT PERFORMED
SOSIP = SOS INDUCTION POTENCY

FIGURE 1

PLOT OF TOTAL DDT-SUBSTRATES MG/KG
VERSUS CARBON CONTENT MG/KG
FOR SCALES POND



PLOT OF TOTAL DDT-SUBSTRATES MG/KG
CARBON CONTENT MG/KG
FOR MIDDLETON POND



APPENDIX A.

TABLE 23.

PARTICLE SIZE AND ORGANIC CARBON CONTENT OF SCALES POND SEDIMENTS

0	STATION	SDATE	PERCENT SAND	PERCENT SILT	PERCENT CLAY	ORGANIC CARBON MG/KG
1	51PE01CB0015	14-MAY-85	12.0	61.5	26.5	46000
2	51PE01CB0015	14-MAY-85				46000
3	51PE01CB0015	14-MAY-85				45000
4	51PE01CB0015	14-MAY-85				46000
5	51PE01CB0014	14-MAY-85	44.0	40.8	15.2	26000
6	51PE01CB0014	14-MAY-85				24000
7	51PE01CB0014	14-MAY-85				24000
8	51PE01CB0014	14-MAY-85				25000
9	51PE01CB0016	14-MAY-85	36.5	45.0	18.5	28000
10	51PE01CB0016	14-MAY-85				30000
11	51PE01CB0016	14-MAY-85				29000
12	51PE01CB0016	14-MAY-85				29000
13	51PE01CB0015	27-JUN-85				65000
14	51PE01CB0015	27-JUN-85				64000
15	51PE01CB0015	27-JUN-85				61000
16	51PE01CB0015	27-JUN-85				58000
17	51PE01CB0014	27-JUN-85				61000
18	51PE01CB0014	27-JUN-85				61000
19	51PE01CB0014	27-JUN-85				61000
20	51PE01CB0014	27-JUN-85				59000
21	51PE01CB0016	27-JUN-85				38000
22	51PE01CB0016	27-JUN-85				41000
23	51PE01CB0016	27-JUN-85				39000
24	51PE01CB0015	23-JUL-85	25.0	50.1	24.9	61000
25	51PE01CB0015	23-JUL-85				60000
26	51PE01CB0015	23-JUL-85				59000
27	51PE01CB0015	23-JUL-85				62000
28	51PE01CB0014	23-JUL-85	26.0	45.9	28.1	69000
29	51PE01CB0014	23-JUL-85				67000
30	51PE01CB0014	23-JUL-85				66000
31	51PE01CB0014	23-JUL-85				62000
32	51PE01CB0016	23-JUL-85	32.0	41.1	26.9	39000
33	51PE01CB0016	23-JUL-85				35000
34	51PE01CB0016	23-JUL-85				39000
35	51PE01CB0016	23-JUL-85				39000
36	51PE01CB0015	29-AUG-85				55000
37	51PE01CB0015	29-AUG-85				56000
38	51PE01CB0015	29-AUG-85				55000
39	51PE01CB0015	29-AUG-85				54000
40	51PE01CB0014	29-AUG-85				63000

(FF)

PARTICLE SIZE AND CARBON CONTENT OF SCALES POND SEDIMENTS MG/KG

0	STATION	DATE	PERCENT SAND	PERCENT SILT	PERCENT CLAY	CARBON MG/KG
41	51PE01CB0014	29-AUG-85				77000
42	51PE01CB0014	29-AUG-85				63000
43	51PE01CB0014	29-AUG-85				64000
44	51PE01CB0016	29-AUG-85				27000
45	51PE01CB0016	29-AUG-85				30000
46	51PE01CB0016	29-AUG-85				27000
47	51PE01CB0016	29-AUG-85				27000
48	51PE01CB0015	29-OCT-85	14.0	57.6	28.4	57000
49	51PE01CB0015	29-OCT-85				57000
50	51PE01CB0015	29-OCT-85				51000
51	51PE01CB0015	29-OCT-85				57000
52	51PE01CB0014	29-OCT-85				67000
53	51PE01CB0014	29-OCT-85				71000
54	51PE01CB0014	29-OCT-85				65000
55	51PE01CB0014	29-OCT-85				65000
56	51PE01CB0016	29-OCT-85	29.0	42.2	28.8	40000
57	51PE01CB0016	29-OCT-85				49000
58	51PE01CB0016	29-OCT-85				41000

TABLE 24.

PARTICLE SIZE AND ORGANIC CARBON CONTENT OF MIDDLETON POND SEDIMENTS

0	STATION	DATE	PERCENT SAND	PERCENT SILT	PERCENT CLAY	ORGANIC CARBON MG/KG
1	51PE01CB0006	15-MAY-85	22.0	60.2	17.8	33000
2	51PE01CB0006	15-MAY-85				35000
3	51PE01CB0006	15-MAY-85				34000
4	51PE01CB0006	15-MAY-85				34000
5	51PE01CB0009	15-MAY-85	17.0	61.2	21.8	37000
6	51PE01CB0009	15-MAY-85				37000
7	51PE01CB0009	15-MAY-85				36000
8	51PE01CB0009	15-MAY-85				35000
9	51PE01CB0012	15-MAY-85	3.0	73.6	23.4	41000
10	51PE01CB0012	15-MAY-85				39000
11	51PE01CB0012	15-MAY-85				39000
12	51PE01CB0012	15-MAY-85				41000
13	51PE01CB0006	28-JUN-85				49000
14	51PE01CB0006	28-JUN-85				49000
15	51PE01CB0006	28-JUN-85				50000
16	51PE01CB0006	28-JUN-85				51000
17	51PE01CB0012	28-JUN-85				56000
18	51PE01CB0012	28-JUN-85				58000
19	51PE01CB0012	28-JUN-85				60000
20	51PE01CB0012	28-JUN-85				56000
21	51PE01CB0006	24-JUL-85	19.0	63.4	17.6	50000
22	51PE01CB0006	24-JUL-85				52000
23	51PE01CB0006	24-JUL-85				51000
24	51PE01CB0006	24-JUL-85				50000
25	51PE01CB0009	24-JUL-85	20.2	60.6	19.2	48000
26	51PE01CB0009	24-JUL-85				50000
27	51PE01CB0009	24-JUL-85				47000
28	51PE01CB0009	24-JUL-85				48000
29	51PE01CB0012	24-JUL-85	19.0	60.2	20.8	53000
30	51PE01CB0012	24-JUL-85				52000
31	51PE01CB0012	24-JUL-85				53000
32	51PE01CB0012	24-JUL-85				52000
33	51PE01CB0009	28-JUL-85				53000
34	51PE01CB0009	28-JUL-85				51000
35	51PE01CB0009	28-JUL-85				53000
36	51PE01CB0009	28-JUL-85				53000
37	51PE01CB0006	28-AUG-85				49000
38	51PE01CB0006	28-AUG-85				52000
39	51PE01CB0006	28-AUG-85				50000
40	51PE01CB0006	28-AUG-85				49000

(FF)

PARTICLE SIZE AND CARBON CONTENT OF MIDDLETON POND SEDIMENTS

0	STATION	DATE	PERCENT SAND	PERCENT SILT	PERCENT CLAY	CARBON MG/KG
41	51PE01CB0009	28-AUG-85				53000
42	51PE01CB0009	28-AUG-85				52000
43	51PE01CB0009	28-AUG-85				53000
44	51PE01CB0009	28-AUG-85				53000
45	51PE01CB0012	28-AUG-85				55000
46	51PE01CB0012	28-AUG-85				54000
47	51PE01CB0012	28-AUG-85				55000
48	51PE01CB0012	28-AUG-85				54000
49	51PE01CB0006	30-OCT-85	14.0	68.8	17.2	47000
50	51PE01CB0006	30-OCT-85				47000
51	51PE01CB0006	30-OCT-85				48000
52	51PE01CB0006	30-OCT-85				44000
53	51PE01CB0009	30-OCT-85	13.0	67.8	19.2	46000
54	51PE01CB0009	30-OCT-85				37000
55	51PE01CB0009	30-OCT-85				44000
56	51PE01CB0009	30-OCT-85				44000
57	51PE01CB0012	30-OCT-85	14.0	67.6	18.4	44000
58	51PE01CB0012	30-OCT-85				38000
59	51PE01CB0012	30-OCT-85				50000
60	51PE01CB0012	30-OCT-85				51000